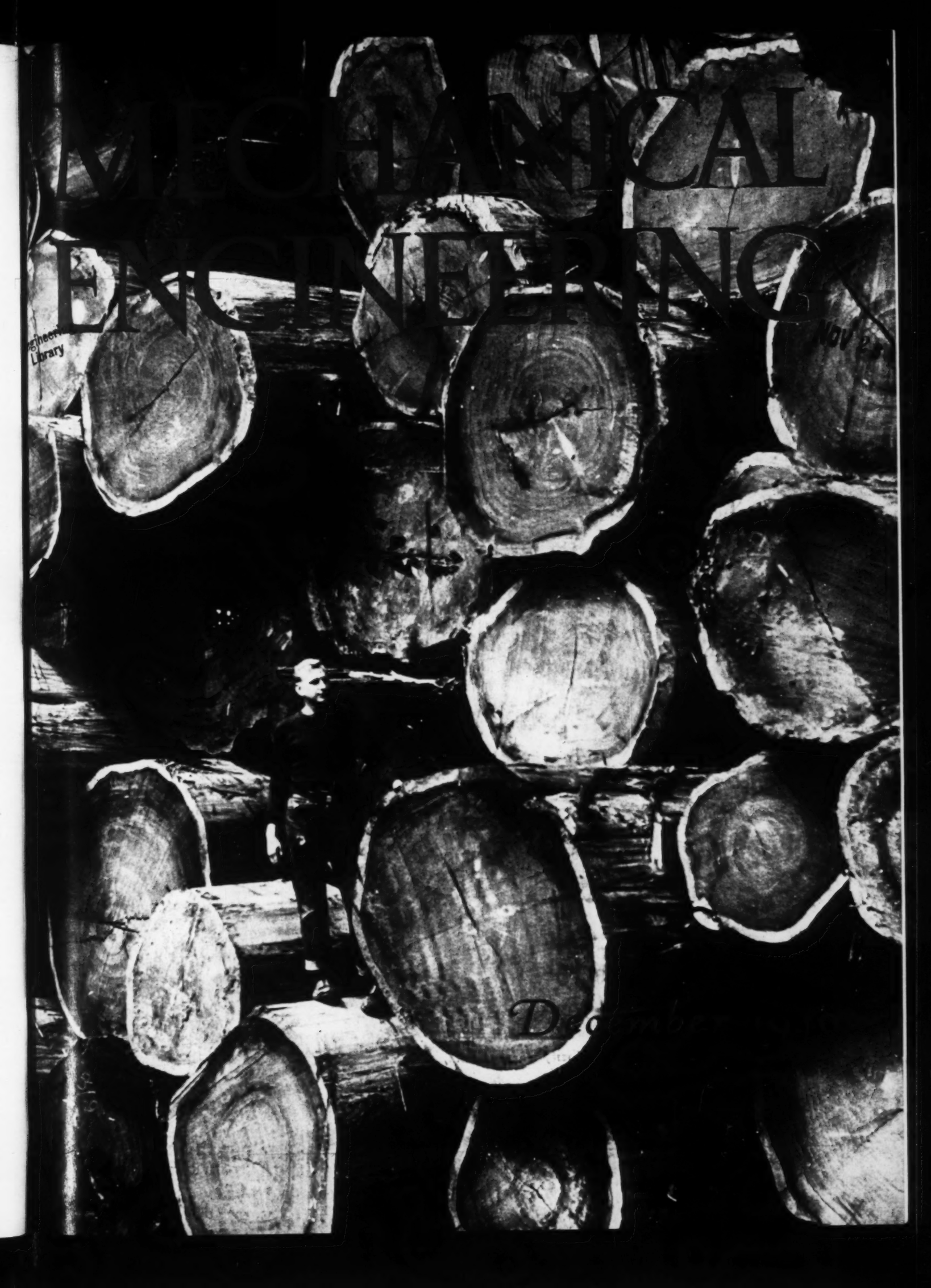
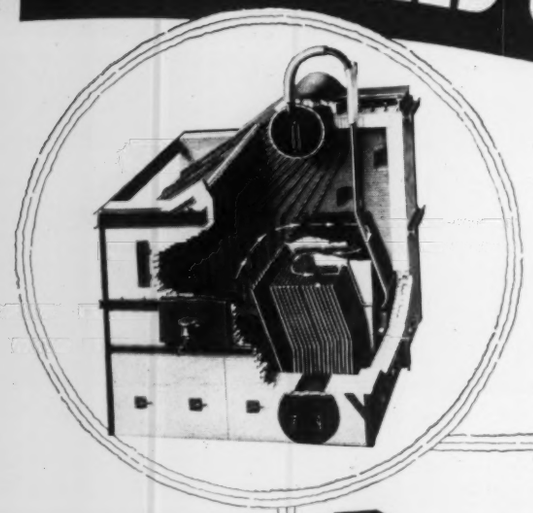
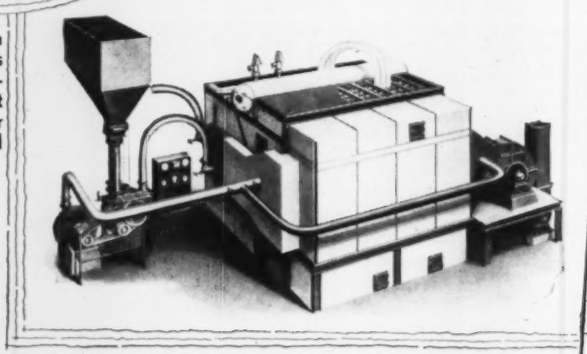

MECHANICAL
ENGINEERING

BOUGHT ON FAITH REORDERED ON PERFORMANCE



Path of gases through slag screen, across large tubes and superheater in first pass, and smaller tubes in the second and third passes.



B&W Integral-Furnace Boiler, a modern, complete unit adaptable to small plants as well as to those of moderate size.

CO.	YEAR AND NUMBER OF UNITS ORDERED							
	'33	'34	'35	'36	'37	'38	'39	'40
A							2	3
B				2			3	
C		1		1				
D	2			1				
E		2					1	
F			2		1			
G					4		2	2
H			1			2		
I				2				2
J				5	2			3
K				1	1			
L					1			1
M					1		1	
N			2			1		
O			1	1	1		1	
P			1				1	
Q					2	1		
R				1			1	
S			1				1	
T	3	1	2		1	2	2	2
U				1			1	1
V				2				1
W							2	3
X			1		2			
Y				3	4	1	1	
Z			1	1				
AA	3		1			1		1
BB				2				2
CC							2	12
DD							2	2
EE							2	1
FF							2	1

Thirty-two industrial companies and subsidiaries who bought B&W Integral-Furnace Boilers have ordered additional units of the same type. The reorders exceed the total of the original purchases by 54 per cent.

The initial orders were placed on faith in B&W engineering and ability and willingness to make every unit perform as expected. Each repeat order was founded on the owner's experience with the Integral-Furnace Boiler itself, a unit that has demonstrated its ability to meet the ultimate test—satisfactory performance.

Owners of these modern B&W Boilers (more than 275 are in service) know that, all costs included, the B&W Integral-Furnace Boiler produces the most steam per dollar.

For detailed description of B&W Integral-Furnace Boilers, ask for Bulletin G-17-A.

The Babcock & Wilcox Company, 85 Liberty St., New York, N. Y.

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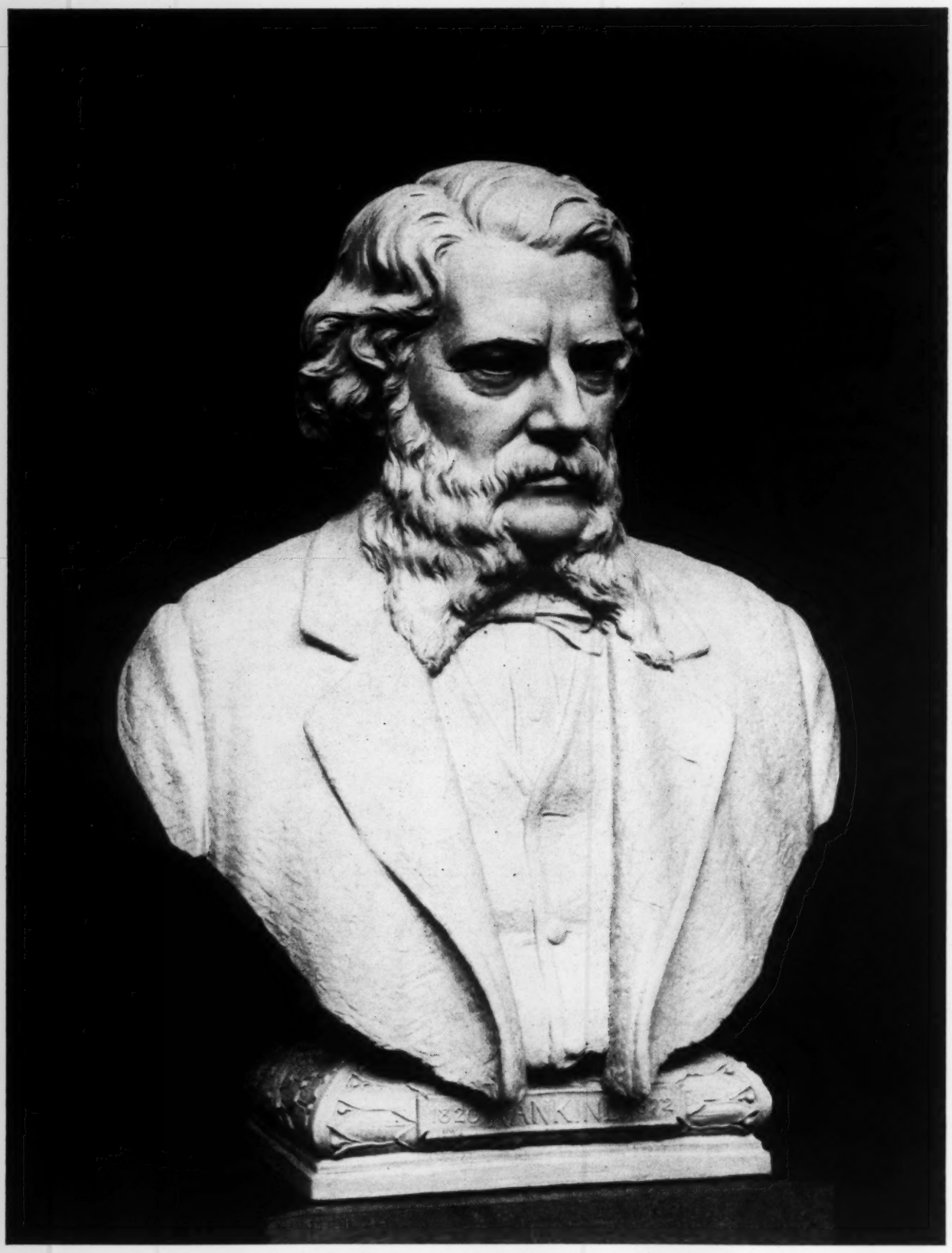


William John Macquorn Rankine, 1820–1872

(*From a bust by Byrant Baker, unveiled on June 8, 1940, at the Virginia Polytechnic Institute, gift of the Class of 1902.*)

VOLUME 62
No. 12

MECHANICAL ENGINEERING

DECEMBER
1940

GEORGE A. STETSON, *Editor*

W. J. M. Rankine

TODAY when we turn our anxious eyes to England whence came the heritage of our speech and literature, the basis of our civil liberties and common law, and the origins of the technology and industrial society that have made us strong and prosperous, it is appropriate to recall a debt to William John Macquorn Rankine whose mind conceived and whose genius helped to build that bridge between science and engineering which research and engineering education afford. Professor at the University of Glasgow where Watt tinkered with the model of the Newcomen engine and laid the foundations of an era dependent upon heat power; writer of textbooks that are classics of engineering literature; seer whose keen insight into Nature's mysteries descried the harmonies fundamental to molecular physics, to elasticity, to thermodynamics, and to hydromechanics; practitioner who brought to civil engineers, steam-engine designers, and shipbuilders rational methods to replace their heroic empiricism; first president of the Institution of Shipbuilders of Scotland; poet, musician, and humorist who kindled the warmth of conviviality amid the austerities of engineers and university dons, Rankine won his numerous achievements in the face of the handicap of poor health. He was one of the great figures of a golden age.

To one who has worked for years under an almost life-size portrait of this great man it was a happy circumstance to meet the Anglo-American sculptor, Mr. Bryant Baker, and to accept from him a photograph of his bust of Rankine, unveiled last June at the Virginia Polytechnic Institute as the gift of the Class of 1902 of that institution. This photograph is reproduced on the opposite page in the hope that it will recall to many prewar students the writer of their textbooks on applied mechanics, civil engineering, and the steam engine, and awaken in the students of today veneration for this remarkable man. A photograph of the bronze tablet on the pedestal of the bust will be found on page 940.

For Defense and Peace

ON these pages in the September issue appeared brief comment on the educational program for defense undertaken by the U. S. Office of Education under the wise planning of Dean A. A. Potter, past-president of The American Society of Mechanical Engineers. It was explained how Dean Potter was attempting to insure use of engineering schools for training at the college level and how he had gone about assessing needs for trained personnel, facilities available in the schools, the minimum educational experience a trainee must have to undertake further intensive study or refresher courses, and the content of such courses.

Further announcement has been made of plans for the establishment in qualified educational institutions of special courses "to be given at government expense, for the intensive training of over 30,000 students with technical background to meet future needs of both industry and the government in carrying out the defense program." The program, financed from an appropriation of nine million dollars, provides for college study both for those able to devote their entire time to preparation for future defense jobs and for workers now employed who desire to fit themselves for more responsible work. Instruction will be on the college level, but special courses of two to eight months' duration will concentrate on immediate practical application to specific defense jobs. Classes will be held in engineering schools and in or near industrial plants for the benefit of part-time and evening students. Regular college teaching staffs will be supplemented where necessary by specially qualified men from industry. The first courses to be established will be designed "to forestall potential shortages of inspectors of materials, chemicals, explosives, instruments, and power units; designers of machinery, equipment, tools and dies, and aircraft power plants, structures, and instruments; production engineers and supervisors; physical metallurgists; marine engineers and naval architects." As other needs become apparent, additional courses are to be added.

Dean Potter's preliminary investigation is now being supplemented by sample investigations into the needs for technically trained personnel in specific areas, including New York, Philadelphia, Pittsburgh, Chicago, and San Francisco. Twenty-two regional advisers, who serve without compensation, have been made available to the Office of Education by selected colleges and universities. Each will act within his own territory "as liaison officer maintaining continual contact with defense industries, Army and Navy district offices, employment services, and other sources of information on personnel needs, as well as with local engineering schools equipped to meet demands for training courses as they arise." Closely cooperating with the entire program is the Advisory Committee on Engineering Training for National Defense, of which Dean Potter is chairman, on which serve several A.S.M.E. members, and of which Allen W. Horton, Jr., is secretary and administrative assistant to the director of the program.

Those who remember the impact of the World War on educational institutions will be grateful to Dean Potter for the statesman-like manner in which he has guided plans for making intelligent use of engineering schools in the present emergency. A great world disorder such as exists today must necessarily disturb the programs of educational institutions. No question exists as to the eagerness of these institutions to be of service, great as regrets may be that disturbance is necessary.

The objectives of war are victory and peace; the consequences of victory are reconstruction and economic and social readjustment. It is not too soon to think of these problems while the war is being waged, for they cannot be escaped once it is terminated. Our generation has lived through one war and its readjustments and consequently the existence of the problems has reality, even if the solutions are confused and unknown. Can the problems of inflation, of trade and markets, of greatly expanded productive capacity, of employment, and of social change be met so effectively as to avoid distress almost as severe as that war itself entails? This is also one of the great problems before the colleges today.

An Old Problem

MANY readers will recall the considerable furor in the press that greeted the article "Post-War Writers and Pre-War Readers" by the distinguished Librarian of Congress, Archibald MacLeish, in which he pointed out that a generation of disillusioned writers had implanted in youth a "distrust . . . . . of all statements of principle and conviction, all declarations of moral purpose." Under the title "Final Things" a graduate of Swarthmore of the Class of 1939, Robertson Sillars, gives the point of view of one young person at least in respect to the MacLeish thesis in an article in the *Journal of Adult Education* for October, 1940. "It is not," he says "'the conviction that there are final things for which democracy will fight' that has been lost, but, to a large degree, the final things themselves." These "final things," which he groups in four categories—religion, the family, private property, and country—are "the things that free people must have and hold, for without them no people can retain their freedom." We must not only arouse "enthusiasm for certain general propositions;" we must restore "real institutions that have . . . . fallen into desuetude and disrepute." Inevitably comes the oft-repeated charge against the "spirit of mechanization." "Concrete ways and means must be worked out, in consonance with our religious conceptions, to reduce the machine to its proper servile function of enriching American families without destroying their independence." And finally: "Our faith in the validity of words and expressions of moral conviction waits upon a sign that the great institutions of civilization are still alive and can establish dominance over the mechanization, instability, and violence of our time."

Engineers who have given serious thought to the tragic dilemma of contemporary society will be sensitive to the opinions expressed by Messrs. MacLeish and Sillars and cannot hear without a twinge of conscience the many forthright and implied rebukes of those who assert or suggest that the machine is the villain of the piece. Denials and attempts to fasten responsibility for misuse on society in general have made singularly little headway beyond the avid acceptance of the benefits of the machine even by the most vigorous of its critics and admission on the part of a few that the problem is not one that concerns the engineer alone. If the engineer has been "hoist with his own petar," the fact that he did not apply the match will not reassemble his scattered members.

Nor can youth extract much comfort from the complaint that it inherits a world confounded by its elders. Youth may tread the skirts of maturity, but close behind it jostles another generation. The youth of today will make a world to be inherited by the youth of tomorrow. Instead of complaints, how much better to say with Pistol, "the world's mine oyster, which I with sword will open." For neither the engineer nor youth will evasion serve, and hence upon the engineer youth a double duty lies. For if he is constrained by his profession to extend the use of the machine which appears to lay the ax to root and branch of human institutions, he must, for the peace of his own mind, cultivate the fundamental truths in which his convictions spring lest he lose them altogether, and he must labor with others toward the same end for the sake of humanity. What if the machine has modified the dogmas of the Church? What if it has altered the pattern of family life by substituting the shop and market place for the hearth and farm? What if it has revised notions of private property as the fencing of Cain's fields laid restrictions on free use of land by his shepherd brother Abel? What if it has expanded the range of men's interests beyond the bounds of their fatherland because of more rapid travel and communication? Are convictions so weak that they cannot withstand the overthrow of dogma, the loosened restraints of family discipline, the shift of notions of ownership, or the impact of unfamiliar folkways? The problem is not new, as history and a rich literature from the Bible to modern times will prove. Not always has the machine been the villain, to be sure, but the assault on conviction, the search for "final things," is old. Indeed, at least one writer, Henry Adams, looked hopefully to the dynamo to supply what appeared to him to be the lost motivation of faith that built Mont-Saint-Michel and Chartres.

It is too much to hope that in one generation will be found the way to strengthen conviction of the reality of "final things" that so powerfully motivates men when it is firmly held. Yet if contemporary events in other lands are not misleading, the youth of Germany have been indoctrinated with a militant faith of their own convictions, regardless of how violently we may abhor them; and the people of England are finding their own in an hour of trial. If engineering is to justify itself as a powerful cultural force, its practitioners and those who educate its young adherents must sense the real problems it poses and restore it to its "function of enriching American families without destroying their independence." The process will be long and difficult.

REDWOOD FOREST MANAGEMENT *for* UTILIZATION

By EMANUEL FRITZ

UNIVERSITY OF CALIFORNIA

SEED TREES LEFT AFTER THE SELECTIVE LOGGING PROCESS
(Some of these trees are 36 in. in diameter at breast height and 250 ft high.)

ALTHOUGH the redwood forests of California have supported active lumbering operations ever since the "gold rush" days, there still remains roughly two thirds of the original stand. At the present rate of cutting, and if there were no provision for regrowth, it would take nearly a century to cut off what is left. It may appear, therefore, that the redwood-lumber industry need have no immediate concern about the future. Actually it has.

For most of the past, the forest was cut clean and nothing was left but stumps, while the cutover land, in large part, became a liability. Because of past low values, no particular thought was given to this matter, except that, between 1922 and 1930, the industry embarked upon a program of replanting the cutover land with nursery-grown seedlings. The planting was costly and the plantations were a failure.

Now the industry wants to know how it can get its money back from its trees and yet leave the land in the condition of an appreciating asset. Consequently, upon the advice of foresters, it has undertaken a program of "selective logging," which is a system of partial cutting that favors natural reforestation. It must be admitted that, when the program was adopted six years ago, the basic information for its successful execution was nothing if not scanty, and each operator had to "feel his way." Since then much progress has been made; interest in further improving selective logging is keen; much information and valuable experience have been acquired; and the benefits are becoming apparent.

Nevertheless, the gaps in forestry and engineering knowledge are yet of such magnitude as seriously to impede the rate of further progress. The job of filling in these gaps is more in the field of engineering than in forestry, although the interrelation is so close that forester and engineer must work together with thorough understanding of each other's aims and problems. This is particularly true if it is the intention of the owner to put his business on a permanent basis rather than to continue it merely to liquidate the original timber and abandon the land. If the owner is not interested in permanence, he can still practice a form of selective logging with some immediate benefit to himself and the job becomes purely engineering, forestry then being only incidental. Since the trend at present is toward permanent production, the engineer will have to work in conjunction with a forester.

FUNCTION OF FORESTRY

Forestry is concerned primarily with the growing, tending, and management of forest properties. The forester's management policy is directed toward keeping the forest land continuously productive of tree crops for whatever use they are intended. Since he deals with a living and growing thing, the forester is in large part a biologist. Forestry, however, is brought into being only by logging. When there is no logging, there is no need for forestry. Since logging is the main activity, the job is largely one of engineering. Most foresters are engaged in the purely forestry phases, and have no understanding of, and often no interest in, the engineering phases. Nevertheless, a few have branched into the engineering phases and have been very successful.

The forester must know the logging engineer's problems, even if he is not directly involved in actual logging because, no matter what system of logging is used, the productivity of the forest land is affected for many years. One system of logging might make it improbable that another forest will promptly take the place of the one cut off. Another system might be ideal from the forester's viewpoint but might make the logging expense too heavy. Conversely, the logger must know what the forest manager is aiming at and he must learn something also of tree physiology. The logger of the future has a more complicated, and more fascinating task than ever before; his job requires more organizing ability than formerly. The owner will judge him not only by how cheaply he delivers logs to the mill but also in how productive a condition he has left the cutover land.

This is as true in the California Coast redwood region as it is in other forest regions. It is one of the most significant of changes in the American lumber industry and one which engineers should watch

Presented at the Fall Meeting, Spokane, Wash., September 3–6, 1940, of The American Society of Mechanical Engineers.

RESULTS OF SELECTIVE LOGGING IN REDWOOD REGION
(The trees remaining standing will be left for future growth and seed dissemination. Note truck road and the loading donkey engine at the right.)

LOGGING METHODS

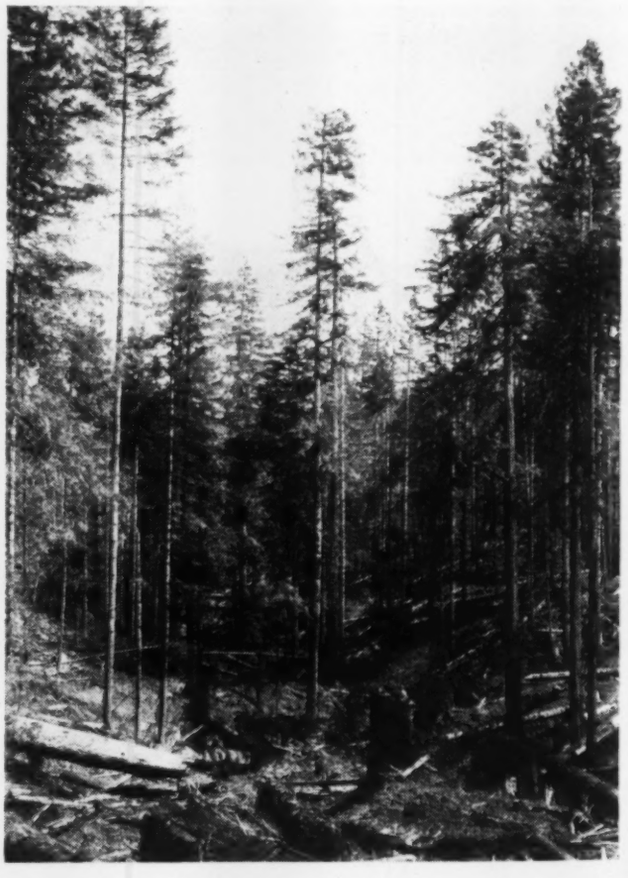
Early logging methods were crude, slow, and laborious. Hand labor aided by screw jacks and animals was the vogue for handling the large heavy logs. Forestry was unheard of. Logging was conservative and left much of the cutover land in fairly good condition for regrowth. However, for 25 or 30 years of the present century, the heavy, powerful, and fast machinery which had been introduced made logging so destructive that planting had to be resorted to in order to assure a second crop. The advent of the modern Diesel-powered track-laying-type tractor made a change to selective logging possible. This machine is rapidly displacing the heavy steam donkeys and the complicated wire-rope systems. Several redwood operators have abandoned steam-donkey yarding engines entirely, and some others use steam only in the winter. Concurrently, railroads are giving way to trucks for transporting the logs to the mill.

Selective logging, from present indications, is the most practical method of cutting redwood and fortunately the tractor is ideally suited to it. It is possible, too, because the redwood forest is a complete mixture of all size and quality classes of trees, and because with the redwood are mixed other and less valuable species, which also vary widely as to size and quality. It is quickly evident to an engineer that all sizes and qualities of redwood cannot be logged for the same unit costs, and all will not yield equally valuable products. The fact must be considered that there might be a size-and-quality class which is of marginal value when costs and returns are measured. To cut anything below this marginal size-and-quality class would entail a cost that is higher than the value of the products. The present program calls for removing only trees of plus value and leaving the remainder, mostly immature trees and large injured trees, for further growth or, in the case of the latter, for such improvement in economic conditions as will give them a value. Later, and as it becomes possible, silvicultural refinements will be introduced, with sustained-yield management the ultimate goal.

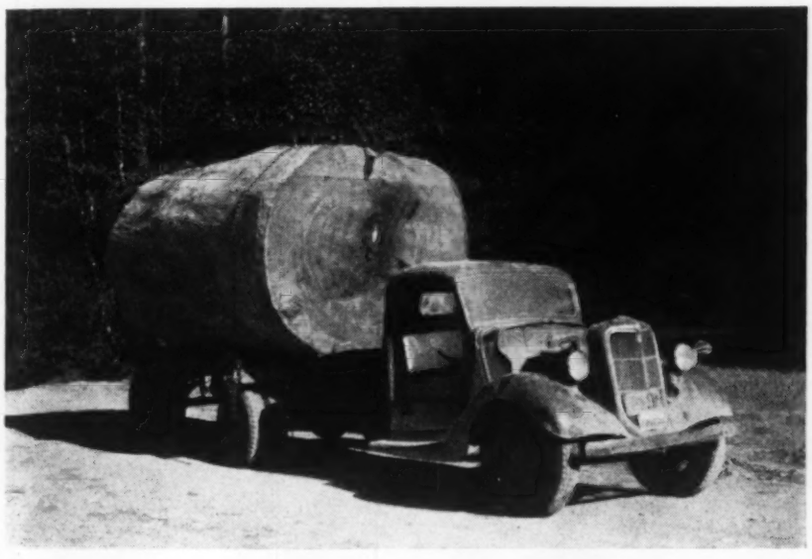
The immature trees, if not seriously injured during the logging and slash-burning operations, have a remarkable capacity to accelerate their rates of growth This is due to the larger growing space available to them subsequent to logging. Recent studies point to an increase in the growth rate from less than 1 per cent per year before logging to often more than 5 per cent per year after logging. This refers only to volume growth. The percentage figure is considerably higher, when value is considered also. Formerly, such trees were destroyed by the donkey-engine and wire-rope systems. Now, where selective logging is practiced, they remain to serve as seed trees for reforesting the gaps and also as a nucleus for a second cut several decades hence when they should have attained merchantable size.

BUSINESS ASPECTS OF SELECTIVE LOGGING

The business implications of selective logging are obvious. By logging only plus-value trees, the unit production cost should decrease, the average lumber quality should increase, and the financial realization should be improved; the cutover land instead of being left as a liability will have on it some residual timber of appreciating value. Consequently, there is a real prospect of continuing the business on a permanent basis. The forester is certain that selective logging will produce the favorable attributes outlined. It remains for the logging manager, the engineer, so to modify his logging technique that



SELECTIVE LOGGING IN THE REDWOOD REGION
(The standing trees are unharmed by felling the mature trees.)



A PEELED 8-FOOT REDWOOD LOG ON A FORD TRUCK

the forester's recommendations can be tried out and his predictions checked. If found correct, the logging manager then has the job of so conducting his operations as to give the owner the full benefit of selective logging.

Selective logging may be described as a small amount of forestry effectuated by a great deal of engineering. This consideration has been mentioned in some detail, because it is rather a new thought in redwood logging. Engineering plays an important part in all the steps of a selective-logging program.

First comes planning. Traditionally, the logger starts at the lower end of his tract and works up and into it; extending his railroad or truck road, and his tractor trails as he goes; cutting everything and abandoning the land. In the days of steam logging and liquidation with no thought of a permanent operation, such an order was understandable. The growing desire for permanence is changing this. The manager now wants to know more definitely how the timber varies from gulch to gulch, even from section to section. This requires more intensive surveys, or "cruising," so that he may know in advance more about the quantity and quality of the timber, and the distribution of size classes.

Selective logging, to be most advantageous to the owner, requires a timber-stand analysis heretofore not needed. This analysis provides an excellent opportunity for the forester and engineer to get together and match wits in planning an operation which not only will be more profitable but which is also permanent. Furthermore, since tractor operation is difficult during the rainy season when it fails to grip firmly or may become bogged, the manager should locate those areas on which tractors can be used during wet weather and then make certain that they are reserved for such seasons and are not logged off during dry weather. Tractors and trucks provide a very flexible combination which offers the manager opportunities for improving his logging never before possible. He can now shift his cutting operations at will to suit timber and economic conditions and he can work around unprofitable trees without injuring them, preserving them for future returns.

REDUCING BREAKAGE LOSS

The felling of redwood timber is another operation that is claiming more careful thought. Cheap and plentiful timber in the past made the matter of breakage one to be taken for granted. Now, however, with mounting operating costs, the breakage loss and its reduction are being examined more seriously. Because of their great length and weight and their brittleness, redwood trees are likely to suffer much breakage during felling. Based solely on the merchantable length and therefore not including the rough tops, felling breakage on rough ground may exceed 20 per cent. Several schemes have been proposed to lower the larger and more valuable trees gently. Two methods have been tried out, but were found to be costly and cumbersome. At present the consensus is that breakage can be mitigated most cheaply by spending more time in preparing a "layout." A good layout is one offering many points of contact in one plane to the trunk. The author feels that, in spite of this general belief, it is highly desirable to continue to explore the possibility of devising a practicable lowering scheme. This and the improvement of the present mechanical-felling machines make good subjects for the engineer's attention.

Redwood bark is very tough and fibrous and, therefore, if not removed makes the sawing of uniform lumber impossible. Consequently, it must be removed before the logs reach the head saws. With a single exception, the operators remove the bark in the woods and later burn it. The one exception is a large operator who removes the bark at the mill and then shreds it for sale as insulation fiber. While this venture is suc-

REDWOOD LOG, PEELED, ON A WHITE 5–7-TON TRUCK AND RELIANCE TRAILER

(The log is 63 in. in diameter at the small end and 36 ft long; contains 6722 board feet.)

cessful, the market as yet is not adequate to absorb all of the bark of the region. Nevertheless, it is desirable to change the present general practice, even if no market can be found for the bark.

Peeling in the woods exposes the naked log directly to the sun, inviting surface checking and consequent loss at the mill. It also deprives the logs of some protection against bruising during yarding. If the peeling could be conducted at a central plant in the woods or at the mill, these losses could be reduced and, in addition, by virtue of the better working conditions, the bark could be removed more effectively and more cheaply. As yet no one has built such a plant for fear that the cost would outweigh the benefits. A central plant involves a rehandling, a matter which becomes serious when the size and weight of the logs are considered.

The one operator now peeling centrally and utilizing the bark is able to charge part of the plant cost to the insulating material. Other operators will not be able to do this. Consequently, the design of a plant in which the bark can be removed and disposed of at no greater cost than is now incurred by woods peeling presents a challenge to the engineer. Foresters are particularly eager to see such a plant developed, because, just as in reducing felling breakage, any loss prevented by central peeling means a saving of timber and consequently a longer life for the lumbering operation on old-growth trees. Removal of the bark with the logs also reduces the volume of slash.

SELECTIVE LOGGING IN REDWOOD REGION

(Residual trees for future growth and seed dissemination. Note the debris which has accumulated at the landing, dragged in, in part, during yarding. It consists mainly of knotty tops and of chunks broken during felling or because of rot. Utilization of this debris presents a formidable problem to the engineer.)

SELECTIVE LOGGING IN A HEAVY REDWOOD FOREST

(The mature trees have been removed. The immature remain for further growth and to act as seed trees. Note deep slash, which had not been burned at time photo was taken.)

DISPOSING OF SLASH

Slash disposal is another management problem which plagues both the forester and the logger. Redwood slash is very dense. It cannot be piled as is done in the pine region. Broadcast burning is the vogue, but this subjects the residual trees to much damage which affects their future value. Modifications of broadcast burning, such as spot burning, are being tried with some success, but the chances of fires going out of control are great. Bulldozer tractors have been tried for gathering the slash in windrows, but the great length of the tops and limbs causes too many tie-ups. Slash must be disposed of to rid the ground of its future hazard, and burning seems the only way out at present.

Efforts are constantly being made to reduce the amount of slash, such as reducing breakage, removing the bark with the logs to a central peeling plant, preserving more of the immature trees, which, when broken down, add to the slash, and others. Several operators, too, have spent, and are still spending large sums investigating possible chemical and mechanical utilization of the enormous amount of waste material left in the woods. It totals, perhaps, more than 300,000 cords per year.

ADVANCES IN YARDING OPERATIONS

Yarding, the operation of moving logs from the stump to the cars or trucks, has experienced the greatest change, as already noted. The cableway systems operated by steam donkeys cause considerable extra breakage. The introduction of the tractor has reduced this loss. Where the cableway systems pull down immature trees because of their straight pull, the tractor can avoid them and thus make their reservation for further growth and future logging possible. The tractor as used in the redwoods is usually supplemented by an "arch," a heavy frame

supported on tractor treads and trailing behind the tractor. It carries an elevated fairlead spool over which the cable and "choker" travel from the log to the winch on the rear of the tractor. The tractor and arch make a very satisfactory yarding unit. Usually two such units and a bulldozer tractor are used for yarding to a single landing or loading point. The organization of their use as to yarding distances, loads, types of trails, disposition, and many other items, offers the engineer-logger a nice problem.

Where the tractor cannot be used as a mobile unit, it can often be set up at a temporary "landing," anchored to stumps and equipped with a double winch carrying 500 to 800 ft of main-line wire rope and perhaps 1500 ft or more of haul-back rope; it could be used in the same way the old steam donkey was used, but with less damage to the logs and the reserved trees and with less cost for each setup.

Transportation of the logs to the mill is an important element in the cost of the logs at the millpond. Railroads are still extensively used but, with the improvement of trucks and highways, truck hauling is becoming established.

A CATERPILLAR RD-8 TRACTOR ARRIVING AT THE LANDING WITH A LOAD; CARCO ARCH

(Note steam heel-boom loader on the track in the background. The loader sits above the track and cars are fed ahead under it to the loading boom.)

A TYPE OF MECHANICAL FELLING SAW NOW IN COMMON USE IN THE REDWOOD REGION

(It was developed in 1929 by pieceworkers to reduce their labor and increase their earnings. It is a standard cross-cutting gasoline dragsaw, slightly modified and supported on its side.)

Redwood logs are very heavy, frequently over 20 tons each. For loading and unloading, the well-known McLeod boom or the spreader-bar system of rigging is used, although small operations may resort to an A-frame. Planning, laying out, constructing, and operating the transportation system is obviously an out-and-out engineering job, and a rather ticklish one, because the track is often to be used only a few years. Therefore, it becomes very important that the road mileage and its cost bear the most economic relation to the volume to be logged.

EFFECT OF TRACTORS ON LOGGING OPERATIONS

The advent of tractors and trucks is bringing about some other changes in the redwood-logging industry. Two such changes are particularly significant. They are making available tracts heretofore considered unprofitable to operate and they are encouraging a "gyppo" or contractor system of logging. Not enough time has elapsed to know what the ultimate effect will be, but indications are that there will be some decentralization of logging, even in one company, and logs will come from a wider area, thus eliminating "bottlenecks."

In turn, this will emphasize the need for establishing log grades and improved log-scaling practices. It is a desirable change and comes at an opportune time. Heretofore, log grading and exact scaling were not necessary but, now that selective logging is becoming the accepted form of cutting, the forester and logger must be able to appraise the log grades in a tree before it is cut and thus determine whether or not it has a plus value. Present scaling practice calls simply for an arbitrary deduction of 30 per cent from the gross scale, defects not being scaled separately as is done elsewhere.

Other details in conducting a redwood-logging operation might be mentioned, but those suggested are "key" steps. In summary, it might be said that redwood foresters and engineers have more difficult operating and management problems than are found in any other forest region. Great size and weight of trees and logs, rough terrain, deep slash, and a tendency toward breakage, make logging difficult and costly. Add to these the requirements of the selective-logging program and you have a combination which challenges the resourcefulness and skill of any group of men.

WOOD-BURNING SPACE HEATERS

A Report on Preliminary Tests of Units Designed Especially for Burning Wood

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THIS paper has the following objects in view: (*a*) To point out the importance of space heaters in general as domestic heating devices; (*b*) to make better known the farm-forestry project for the rehabilitation of woodlands back to timber-producing areas; and (*c*) to stimulate the interest of engineers and engineering societies in the problem of wood burning. While the first two objects are collateral in character, they do serve to explain why the subject matter of this paper is justified and why the interest of others is being solicited. The main body of the paper will have to serve the third object. In any comparatively new undertaking, preliminary work ought to be valuable for the problems it finds as well as for the affirmative facts which may be uncovered. In general, all references in this paper relate to American publications and practices.

Space heaters may be described as relatively small devices used primarily for domestic heating purposes. They are installed in the room to be heated and may heat adjacent rooms by the movement of air through communicating doorways. Except in the South, where fireplaces are in common use, the space heater, combined with the kitchen stove, is almost wholly employed in rural homes. In addition, the same arrangement heats about 45 per cent of the one- and two-family homes in urban communities. This means that the majority of American families are not enjoying the fruits of modern engineering (i.e., automatic heat, air conditioning, and the like). Heating is a service closely related to public health and comfort. With so many millions of persons involved it ought to be clear that space heaters warrant the highest degree of engineering skill.

A study of the Transactions of the American Society of Heating and Ventilating Engineers reveals only one paper[1] in a period of forty-five years devoted to space heaters. The following quotation is just as pertinent today: "Consider the number of these stoves now manufactured and used. Where are there any tests recorded which determine the efficiency or the relative merits of the various types in use?" A similar study of the Transactions of The American Society of Mechanical Engineers, covering sixty years, shows no paper on stoves or space heaters.

Something is known about space heaters fired with gas or oil. Very little is known about coal-fired space heaters and next to nothing where wood is burned. In fact, the general subject of wood burning has received little attention in any connection. The American Society of Mechanical Engineers has published a few papers on the utilization of wood waste with major emphasis on furnace design. There was also a very complete paper[2] years ago on tests with tan bark referred to later.

[1] "Tests to Determine the Efficiency of Coal Stoves," by F. B. Rowley and John R. Allen, Trans. A.S.H. & V.E., vol. 26, 1920, p. 115.

[2] "Tan Bark as a Boiler Fuel," by David Moffat Myers, Trans. A.S.M.E., vol. 31, 1909, p. 685.

Contributed by the Fuels Division for presentation at the Annual Meeting, New York, N. Y., Dec. 2–6, 1940, of The American Society of Mechanical Engineers.

Probably the earliest published account of wood-burning tests showing real merit may be found in Count Rumford's essay, "The Management of Fire and the Economy of Fuel," published in 1797. One of Count Rumford's problems was whether the heat of combustion was produced by the wood or by the air. About only one important discovery was ever made on fuel wood. That was the distillation of wood and the production of charcoal. The ancient Greeks thought highly of this discovery since it made it possible for fuel to be burned in the room on an open hearth or in a brazier without producing smoke. (Smokeless fuel is probably the only sound means of smoke prevention.) In America, Benjamin Franklin invented the fireplace stove about 1740 in order to economize on wood which he feared would be gone in about one hundred years. Now, two hundred years later, we have great quantities of wood in certain sections of our country with too much of it, due to bad forestry practices, suitable only for fuel purposes. Surprisingly or not, the fact remains that there is little combustion data on wood and practically nothing on wood-burning space heaters.

The farm-forestry program mentioned earlier furnished the incentive for the preliminary work to be reported herein and for the manufacture of an American wood-burning heater. It is a program of conservation. Conservation probably appeals to no group so strongly as to engineers.

In the first place, when forests are being cut primarily for timber, approximately 30 to 40 per cent of the wood, constituting the branches and trimmings, is useless as timber. The sale and use of these trimmings would afford an income and would tend to reduce a serious fire hazard. Secondly, where forest lands have been completely cut over and new growths are springing up without attention, many years will be required before good marketable timber will be available. However, good forest management, which involves judicious and regular thinning, could, in a shorter time, establish a new and valuable forest which might be maintained indefinitely as a constant source of marketable timber. One of the problems of such a program is to provide a steady demand for the trimmings and small stuff removed in the thinning process, and this relates directly to the subject at hand. Note that heating, along with food, clothing, and shelter, involves the nearest approach to a steady or predictable demand.

The program of conservation just outlined would constitute a national asset and would provide additional employment and income. But, on the other hand, it must be economically attractive if it is to succeed. The critical problem is to create an adequate market for the trimmings, the sale of which must provide income sufficient to justify the cost of maintaining forests or restoring wooded areas. The utilization of wood is progressing rapidly through chemical research, but it is believed that the use of wood for fuel purposes will continue to be an important factor.

As a general rule, fuel wood cannot be transported profitably more than 25 miles. Hence, marketing of fuel is a problem

of finding a local market of sufficient size. This probably means use of the fuel in homes rather than in factories. At the present time, people use wood as a fuel only when forced to do so—ornamental fireplaces excepted—and in some localities it is the only fuel available at a reasonable price. Any heating device that could show greater convenience and ease of attendance should ultimately encourage the greater use of fuel wood.

Desirable requirements for a wood-burning space heater are given in what follows. The heaters tested were intended to meet these requirements as nearly as possible.

(*a*) Refueling and attention periods should be comparable to those attained by anthracite coal.

(*b*) The heater must be easily adjusted to any fuel-burning rate and be able to hold that rate for long periods (i.e., 24 hours) or, better yet, be amenable to automatic control.

(*c*) Both the solid fuel and the gases must be completely burned without too much excess air. Only by complete combustion can creosote formation and its attendant fire hazard be eliminated.

(*d*) The ash pan must hold enough ash so as to require ash removal about once or twice each week.

(*e*) The refueling must be easy and convenient and the design must be such as to avoid the discharge of smoke and gas into the room during the refueling operation.

(*f*) It must operate most efficiently when small fuel wood (i.e., 4 in. or less in diameter) is used.

DESCRIPTION OF HEATERS TESTED

A heater of a European type (heater *A* of this paper) was brought to the attention of the authors by Edgar L. Heermance, secretary of the Connecticut Forest and Park Association, as a result of a survey, in Europe, made by the late Prof. W. C. Bryant, of the Yale School of Forestry. Heater *A* is characterized by the large amount of refractory employed. The heater, though small, weighs 430 lb, owing largely to this reason. The heater is rated at 20,000 Btu per hr.

Heater *A* consists of a magazine, $10^1/_2$ in. wide, $9^1/_4$ in. long, and 19 in. high, holding about 18 lb of wood when closely packed with random sizes of sticks. At the bottom of the magazine there is a grate, about 9 in. by 10 in., and the grate is about 5 in. above the floor of the ashpit. The top of the magazine is closed by a hinged metal door through which fuel is charged. About 3 in. above this door is a second door, forming part of the top surface of the heater. The rest of the heater top is made up of a casting which contains side passages which connect the upper end of the secondary combustion space with the smoke outlet. The base of the heater, containing the ashpit, is also a casting. The main body of the heater, containing the magazine and secondary combustion spaces, is composed of refractory surrounded by a sheet-iron jacket.

Air enters through a damper located at the back (see Fig. 1*a*) of the base casting but adjusted by a small lever protruding through the front. This supplies both primary and secondary air. Primary air passes through the grate and supports combustion in a limited zone directly above the grate. Secondary air passes under the grate, to the front of the heater, where it rises into the secondary combustion passages. In so doing it flows through passages between refractory walls which are heated by hot gases from the combustion zone, and out, into the secondary combustion passages through small holes or tuyères in the refractory. Three sets of such tuyères are provided with spaces between leading from the primary combustion zone over the grate to the secondary combustion passages. The arrangement is intended to insure good mixing of the secondary air with the gases coming from the magazine and combustion zone.

Heat from the combustion zone produces destructive distillation of the fuel above, and, since the magazine is closed at the top, the distillation products are forced to flow out through the passages mentioned. Upon mixing with the secondary air, these products are burned in the secondary combustion passages and then pass out of the top into the two passages at each side of the casting leading to the smoke outlet.

In the top, front side of the magazine is a slide damper connected to a rod which projects through the outer surface of the heater. By opening this damper it is possible to pass air and gases up through the fuel in the magazine, in the common updraft manner, thus short-circuiting the secondary combustion chambers. The object of this device is to kindle a new fire rapidly, or to revive combustion quickly, until the temperature becomes high enough to support secondary combustion in the small combustion passages. This arrangement of the draft is only temporary, the damper being closed as soon as its purpose has been served.

It will be noted that the air and gases normally flow across the bottom of the fuel bed resting on the grate. In this way a uniform fuel-bed condition is maintained until the fuel charge is nearly exhausted. Hence, if combustion conditions are proper, they will remain so during the life of the charge which may be as much as 24 hours.

Heater *B*, of American design and manufacture, is characterized by almost complete use of cast iron. A soapstone plate forms a partition between the fuel magazine and the secondary combustion space (see Fig. 2*a*). The use of cast iron in this partition would result in overheating and buckling. A cleanout door, lower front, is lined with refractory material. The side walls of the secondary combustion space are covered with refractory to a height of about 6 in. above the grate level. Thus refractory walls are provided in that portion of the heater devoted to secondary combustion.

The magazine is 12 in. by 17 in. and 19 in. high, is closed at the top with a hinged door, and holds about 45 lb of wood. The front, back, and sides of the heater are cast-iron plates, with reinforcing ribs. The top of the heater is formed almost entirely by a second hinged plate or door about 3 in. above the magazine door.

The principle of operation is practically the same as in heater *A*, namely, that which would be applicable to the burning of any high-volatile fuel. A damper at the back of the ashpit wall controls the flow of air into the ashpit. Both primary and secondary air are derived from this common source. The primary air passes through the grate and supports combustion in the zone directly above. The secondary air rises through passages in front of the fuel magazine and slightly above the grate level. The secondary air is heated and supplied through numerous small tuyères which are intended to provide good mixing with the gases coming from the magazine. The unconsumed products of distillation of the wood are forced into the active zone and heated prior to entering the secondary combustion space. The principal difference in gas path is that, in heater *B*, the gases pass directly through the space between the top door and the magazine door to the smoke outlet without the complication of the bifurcated passages as in the case of heater *A*.

Heater *B* is rated at 40,000 Btu per hr. It weighs about 405 lb and is better suited to standard American cuts of wood than heater *A*.

Another innovation in heater *B* is that, when the upper door is opened, the damper at the back of the ashpit closes automatically. In addition, as the magazine door opens, it closes the vertical flue leading up from the secondary combustion space. These features are provided in an effort to prevent the escape of gases into the room during refueling.

GENERAL DESCRIPTION OF TESTS

The simplest method to test the heating effect of a stove or heater, and the only one used heretofore, is to determine the chimney losses and credit the remaining heat, of the fuel, to the stove or heater as useful effect. In order to measure the weight of fuel burned at any time during the test the heater was placed on a platform scale which was sufficiently sensitive to show changes of weight with an accuracy of 0.25 lb under the total load imposed. The smoke pipe was rigged with a loose slip joint so as not to interfere with the accuracy of the weighing. There was no friction in this joint since the two pipes were not in actual contact. Since the weight of the wood ash is less than 1.0 per cent of the weight of the original wood, it follows that any change in weight observed during the burning period substantially represents the fuel actually burned.

Flue-gas determinations were made at intervals of 10 min in some tests and at 20-min intervals in others, readings being taken of CO_2, O_2, and CO in every analysis. In tests of heater *A* flue-gas analyses were made at the smoke outlet only. In the case of heater *B* gas analyses were taken near the top of the secondary combustion chamber and at the smoke outlet. Flue temperature was taken with a mercury-in-glass thermometer every 10 min in short tests and 15 min in longer tests. In the tests of heater *A* the smoke pipe was not insulated on the outside and hence the temperatures for these tests may be somewhat in error; they may be lower than the actual flue temperatures. The smoke pipe was lagged with high-temperature insulation for the tests of heater *B* according to present practice. Drafts were measured with the standard inclined-tube draft gage.

Tests of each heater were made at a number of fuel-burning rates. The fuel used for most tests was mixed red, black, and white oak sticks, of a length suitable for the magazine chambers and not over 4 in. in diameter. The manufacturers' directions called for packing the wood into the magazine as tightly or compactly as possible, smaller diameter pieces being preferred to improve the closeness of packing.

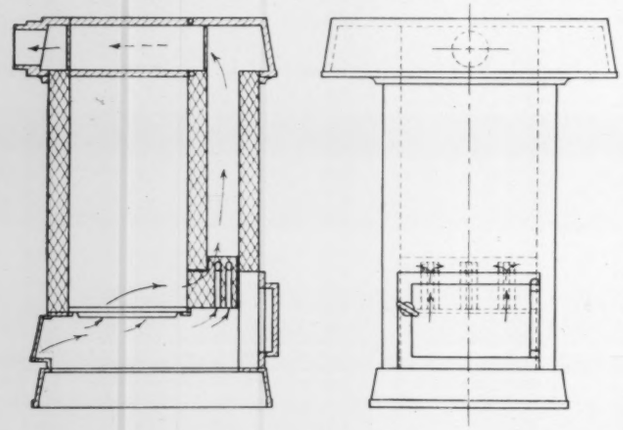

FIG. 1*a* HEATER "A"

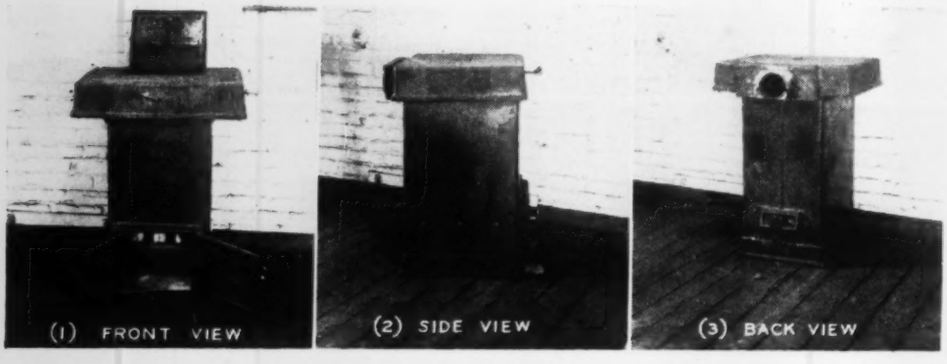

FIG. 1*b* THREE VIEWS OF HEATER "A"

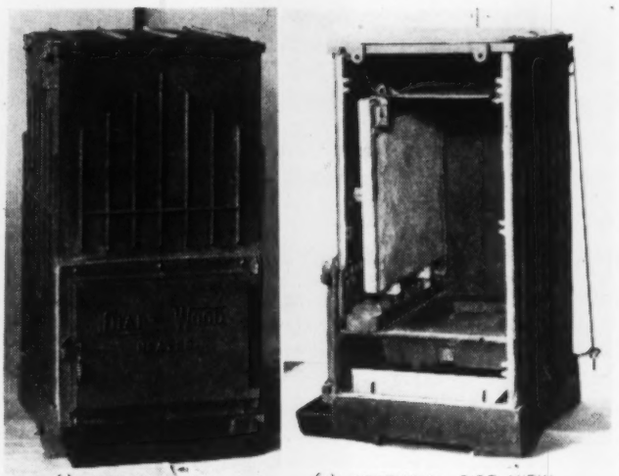

FIG. 2*a* HEATER "B"

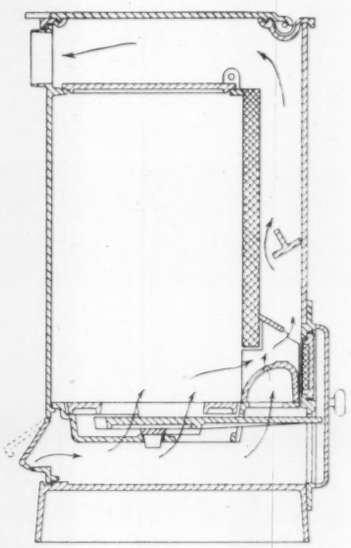

FIG. 2*b* HEATER "B"

In general, the tests may be classified into three categories: (1) Tests with seasoned wood fuel on both heaters, (2) tests with charcoal in heater *A*, and (3) field tests with green wood, dry wood, and sawdust. At least one laboratory test with green wood was made on each heater.

Fires were started with a small kindling charge on the grate which was allowed to burn for about half an hour or more until the secondary combustion passages were thoroughly heated. The importance of this procedure is stressed by the manufacturers and was verified by experience. After the preliminary heating period, the magazine was charged full, care being exercised to pack the pieces closely, the weight was recorded, and the test begun and carried forward until the fuel-bed condition was approximately the same as before the charge was made. This was indicated by a return to the original weight prior to the full charge. A full charge for heater *A* was about 18 lb and for heater *B* was about 45 lb.

The field tests were conducted in a Vermont farmhouse

during the latter part of March and the early part of April, 1938. No measurements were taken during these tests, since the object was to observe the operation from a practical standpoint; uniformity of heating, ease of regulation, and attendance were studied. Various fuels were tried, including regular seasoned stovewood, small maple blocks, and sawdust (waste from a nearby sawmill and green stovewood).

In the laboratory tests, moisture samples were taken on all fuels used. In the case of wood the moisture determinations were made on borings, on whole sticks, and on small sections cut from large sticks. These samples were dried in a thermostatically controlled oven adjusted to a maximum temperature of 220 F. Dessicating agents were placed in the oven to absorb the moisture given off. It is highly important to control temperature in drying because destructive distillation begins at a fairly low temperature (380 F). Samples were dried for 48 hr before any weighing of the samples, after which they were dried further until a constant weight was observed. Bone-dry wood is highly hygroscopic and it is necessary to weigh the samples quickly after they have been completely cooled in a desiccating dish. Weighing samples while hot will result in errors, and the balance housing should also contain desiccating material and the balance-housing door should be kept closed as much as possible. In damp weather, when these precautions were not observed, it was impossible to get a weight of the sample because moisture was absorbed by the sample faster than the balance could be manipulated.

The moisture determinations on the full-size sticks and blocks required a much longer time for drying because the moisture comes out slowly. Borings were taken with a new, sharp bit to insure rapid cutting with a minimum of heat generated, and borings were taken from a large number of sticks in order to obtain a representative sample. Reasonably close checks of moisture content were obtained by these methods.

No ultimate analyses of the fuels were made since ample data were available from various publications. The analyses given in Gebhardt's "Steam Power Plant Engineering" were used since the heating values agreed with actual heating-value determinations made with an Emerson oxygen bomb calorimeter on the fuel used in the tests. Since the fuel used was a mixture of red, black, and white oak, an average analysis was computed from the data on these three species. This analysis was corrected for moisture content as required. Heat value was calculated in the same way and checked by calorimeter as stated. The agreement was reasonably close.

TABLE 1 SAMPLE CALCULATIONS

Test No. 1*A* Heater *A* — Wood fuel, 17.2 per cent moisture as fired
Damper setting, No. 4
Fuel rate, 3.6 lb per hr — Heating value, 7088 Btu per lb as fired
Draft, 0.077 in. water — Carbon in fuel, 41.05 per cent as fired
Flue temp, 324 F — Hydrogen in fuel, 5.30 per cent as fired
Room temp, 63 F

$CO_2 = 6.7$ $O_2 = 13.3$ $CO = 1.2$ $N_2 = 78.8$

$$\text{Gas per lb of fuel} = \frac{4 \times 6.7 + 13.3 + 700}{3 \times (6.7 + 1.2)} \times 0.4105 = 12.84 \text{ lb per lb}$$

$$\text{Air per lb fuel} = \frac{3.03 \times 78.8}{6.7 \times 1.2} \times 0.4105 = 12.41 \text{ lb per lb}$$

Heat loss to dry gas $= 12.84 \times 0.24 \times (324 - 63) = 802$ Btu
Heat loss to hydrogen $= 9 \times 0.053 \times [1090 + 0.46\,(324 - 63)] = 577$
Heat loss to moisture in fuel $= 0.172\,[1090 + 0.46\,(324 - 63)] = 208$
Heat loss to incomplete combustion $= 0.4105 \left(\frac{10160 \times 1.2}{6.7 + 1.2}\right) = 634$

Total stack losses ..... 2221 Btu
Useful effect $= 7088 - 2221 = 4867$ Btu per lb of fuel as fired

$$\frac{4867}{7088} = 0.687, \text{ or } 68.7 \text{ per cent efficiency}$$

Heat release $= 3.6 \times 7088 = 25{,}500$ Btu per hr

Heat loss to moisture in the draft air was not computed since it is so small as to be within the experimental error

Tabulation of the results will be found in Table 1. Efficiencies plotted against heat release rates are shown in Fig. 3. All tests were computed on the basis of over-all averages for the duration of the test.

The efficiency was determined by calculating the stack losses according to standard engineering practice. The difference between the stack losses and the heat value of the fuel was credited to the heater as useful effect. A sample set of calculations is given in Table 1.

Inspection of Fig. 3 discloses that the efficiencies tend to increase at the lower heat release rates. This is due to the fact that flue temperatures are lower at the lower ratings which decreases all stack losses except the loss due to incomplete combustion. Hence more heat of the fuel consumed is credited to useful effect. If stack losses could be reduced still further, the efficiency of a heater would approach 100 per cent as a limit, which is in direct contrast to the case of a boiler.

Fig. 4 is a plot of flue temperature against heat-release rates and shows an increase in temperature with rating, similar to that found in other types of heating equipment. Fig. 5 is a similar graphical representation of the variation of CO_2 with heat release rate which, likewise, shows characteristics similar to those encountered in hand-fired coal furnaces.

TABLE 2

Test no.	Fuel used	Fuel rate, lb per hr	Flue temp, F	CO_2, per cent	O_2, per cent	CO, per cent	Heat release, Btu per hr	Efficiency, per cent
1*A*	Wood	3.60	324	6.7	13.3	1.2	25,500	68.7
2*A*	Wood	2.90	306	6.5	14.0	0.9	20,550	63.3
3*A*	Wood	1.90	261	7.6	12.5	0.9	13,480	75.7
4*A*	Wood	1.00	158	9.7	10.1	1.6	7,088	78.8
5*A*	Wood	0.43	179	4.9	14.7	1.2	3,050	71.7
6*A*	Wood	2.18	324	5.0	15.7	1.1	15,450	64.8
7*A*	Wood	1.19	208	5.0	15.2	1.5	8,425	69.4
8*A*	Wood	2.67	500	5.4	14.8	0.3	18,900	59.3
9*A*	Green wood	2.00	495	4.7	15.5	0.5	11,980	50.4
11*A*	Charcoal	2.73	613	10.5	9.7	0.4	33,000	76.5
12*A*	Wood	4.88	635	10.4	9.5	0.7	36,900	68.6
13*A*	Green wood	3.18	448	5.9	14.6	0.7	19,050	59.2
14*A*	Charcoal	1.59	574	6.6	13.7	0.3	19,200	68.5
15*A*	Charcoal	1.10	407	5.8	14.4	0.6	13,300	76.3
16*A*	Charcoal	0.78	269	4.7	15.3	0.8	9,400	75.3
17*A*	Charcoal	0.80	3 5	4.6	15.6	0.6	9,680	73.7
18*A*	Wood	1.55	364	8.2	11.9	0.8	11,000	72.8
19*A*	Charcoal	0.95	270	7.2	12.4	1.1	11,500	80.7
20*A*	Charcoal	0.57	190	5.7	14.1	0.8	6,890	83.3
1*B*	Wood	9.33	658	9.0	11.2	0.6	67,150	63.0
2*B*	Wood	5.18	489	8.1	12.1	1.0	36,400	65.8
3*B*	Wood	2.61	186	4.4	16.1	0.9	18,350	72.2
4*B*	Wood	1.48	195	3.0	17.5	0.6	10,400	68.3
5*B*	Wood	8.31	403	5.9	20.6	1.0	58,300	63.3
6*B*	Wood	6.00	490	6.1	14.5	0.5	42,100	62.0
7*B*	Wood	6.77	503	9.9	10.1	0.7	47,500	70.2
8*B*	Wood	1.56	178	2.8	17.6	0.5	10,950	70.0
9*B*	Wood	6.82	552	7.5	12.6	0.8	47,900	62.2
11*B*	Wood	4.12	342	3.8	16.8	0.5	28,900	61.0
12*B*	Green wood	2.88	158	3.6	17.2	0.5	15,870	71.2

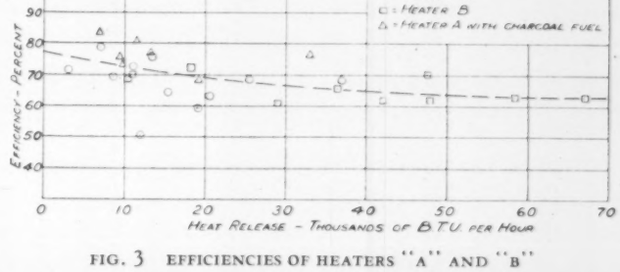

FIG. 3 EFFICIENCIES OF HEATERS "A" AND "B"

Draft loss was not measured in the tests of heater *A* so that the curve in Fig. 6 represents the data for heater *B* only. The draft loss was measured between the ashpit and the smoke outlet and the graph shows the kind of characteristic which would be expected.

The firing-period curves (Fig. 7) were computed on the basis of the time required to burn a full magazine charge at various heat-release rates. A separate curve is shown for each heater, since heater *A* held only 18 lb, while heater *B* took about 45 lb. Heater *B*, rated at 40,000 Btu per hr on an 8-hour refueling basis, shows remarkable agreement with the calculated value. Heater *A* would have to be rated on a 6-hour refueling basis for 20,000 Btu per hr, as stated by the manufacturers.

The life-history curve of a typical test is shown in Fig. 8. This test (test No. 4*B*) was one of the longer tests (26 hr) at a heat-release rate of about 10,400 Btu per hr, or approximately 25 per cent of rating. A fairly constant burning rate is shown by the fuel curve after the first two hours of operation and the flue temperature also becomes fairly constant at the same time. The variations in the CO_2 curve are indicative of the changing fuel-bed conditions due to settling of the charge.

SPECIAL OBSERVATIONS

The field tests, mentioned previously, showed in general ease of firing, freedom from attention (in comparison with the old-fashioned and common iron stoves), and ability to hold a fire for long periods. It was found that green wood could be used successfully at rapid burning rates but was not advisable at slow burning rates because of the possible condensation of water vapor in the flue gases. It was quite clear that short smoke pipes, sloping toward the chimney, are desirable. Sawdust was tried in heater *A* only and burned well, but the firing periods were undesirably short.

It was discovered that smoke could be practically avoided if the rate of combustion was kept low for a short period just prior to charging the magazine. The distillation period should be complete before attempting to charge the magazine, in which case the charging doors may be opened without smoke. While the fresh charge is being placed in the magazine some smoke cannot be avoided but can be kept to a minimum by making the refueling operation as short as possible. The fact that refueling is required only at infrequent intervals is a decided advantage of this type of heater.

Discussion of the problems of wood burning and flue-gas analysis, given later in the paper, raises the question of the adequacy of the Orsat analysis for accurate determination of unburned combustible gases. An attempt to cast some light on this matter was made by employing a device used to analyze the losses in internal-combustion-engine exhaust gases. Such devices oxidize all of the unburned products and the heat produced by the reaction, by means of suitable apparatus, causes a pointer to indicate the losses in terms of carbon monoxide. The device used in these experiments was the Cities Service power prover, type *AF*.

It was assumed that, if the only combustible in the flue gas was CO, then the power prover and the Orsat should agree. If there were other combustible gases, in addition to CO, then the power-prover indication should be higher than the Orsat. While the immediate object of this experiment was as stated, other objectives were a check on the CO indications of the Orsat and indications of combustible gases in the magazine.

In order to get a comparison of the Orsat and power-prover

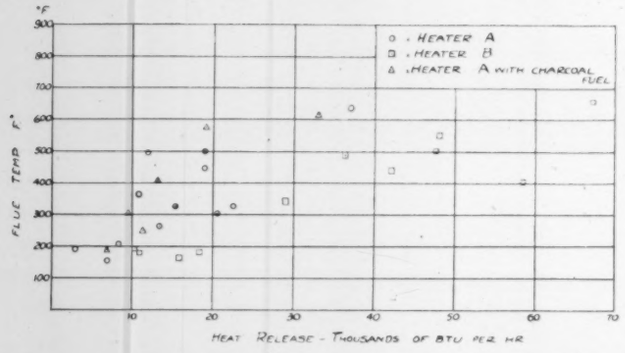

FIG. 4 FLUE-GAS TEMPERATURES, HEATERS "A" AND "B," AT VARIOUS RATES OF HEAT RELEASE

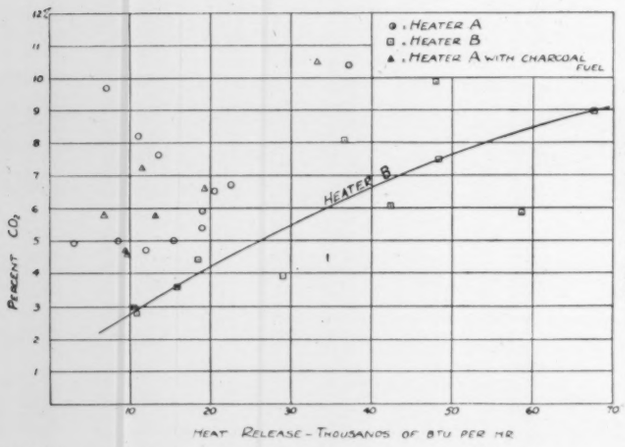

FIG. 5 CO_2 IN FLUE GAS, HEATERS "A" AND "B," AT VARIOUS RATES OF HEAT RELEASE

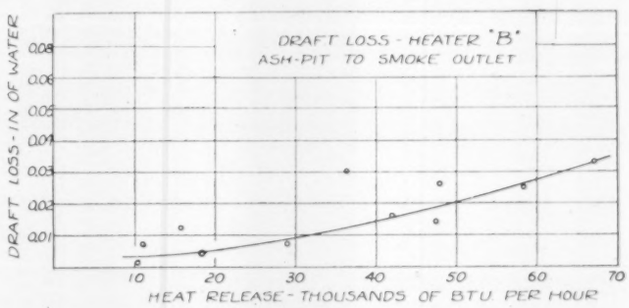

FIG. 6 DRAFT LOSS, HEATER "B," ASHPIT TO SMOKE OUTLET

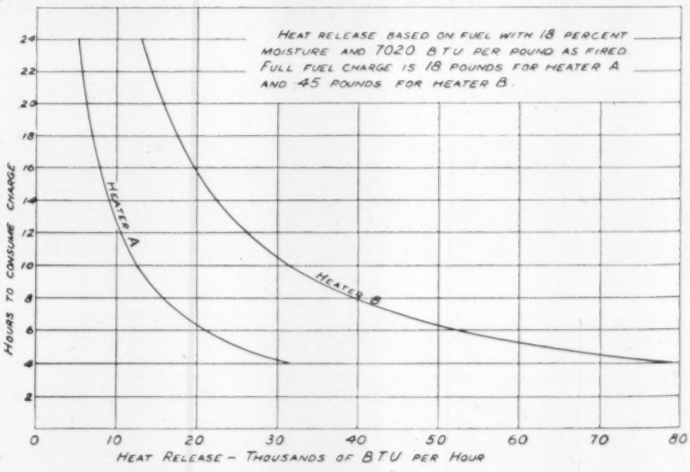
HEAT RELEASE BASED ON FUEL WITH 18 PERCENT MOISTURE AND 7020 BTU PER POUND AS FIRED. FULL FUEL CHARGE IS 18 POUNDS FOR HEATER A AND 45 POUNDS FOR HEATER B.
HOURS TO CONSUME CHARGE
HEATER A
HEATER B
HEAT RELEASE - THOUSANDS OF BTU PER HOUR

FIG. 7 HEAT RELEASE BASED ON FUEL WITH 18 PER CENT MOISTURE AND 7020 BTU PER LB AS FIRED
(Full charge is 18 lb for heater "A" and 45 lb for heater "B.")

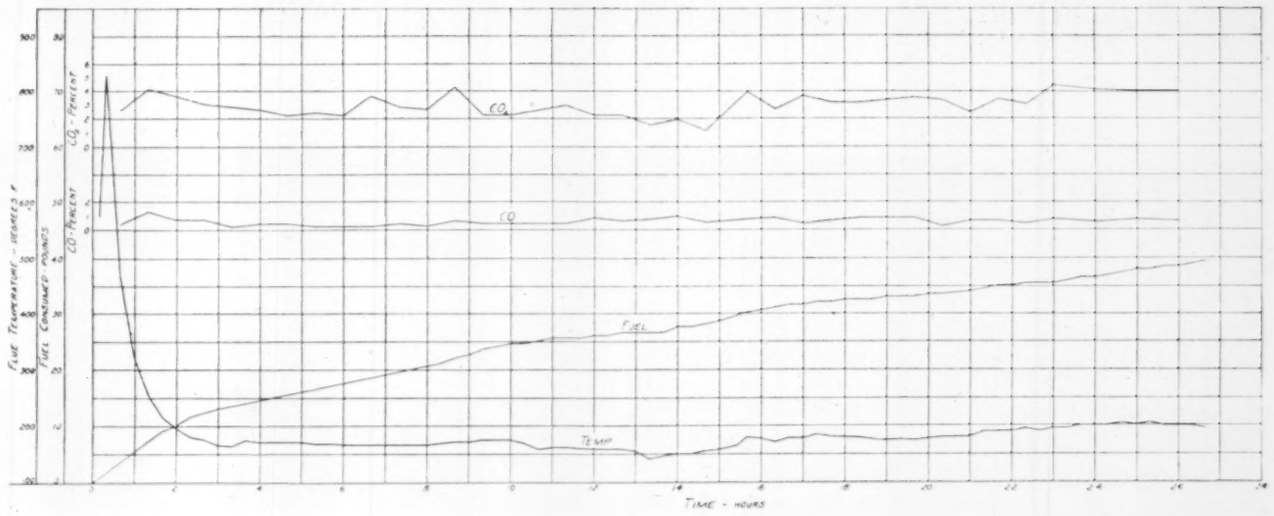

FIG. 8 LIFE-HISTORY CURVES OF TYPICAL TEST

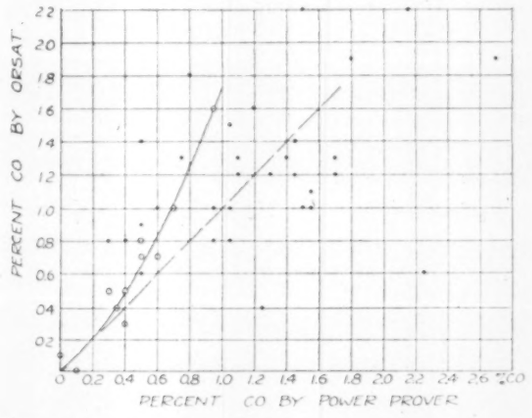

FIG. 9 COMPARISON OF ORSAT AND POWER-PROVER INDICATIONS (Points in circles show CO by Orsat vs. power prover with same sample of gas from charcoal. Simple points show CO by Orsat vs. power prover with same sample of gas from wood fuel.)

indications, samples were taken from the same point within a half minute of each other while charcoal was being burned because of the greater chance that the unburned gases would be CO alone. Fig. 9 indicates that the power-prover indications were low. Had the indications been alike the points would have fallen on the dashed 45-deg line. The circled points are the ones obtained using charcoal fuel; the other points are those obtained when comparisons were made with wood as the fuel. The wide range is believed to reflect variations in the combustibility of flue gases to which the Orsat is not responsive, and shows that a better and more complete method of gas analysis is definitely required for wood fuel.

When used in the trials with wood as fuel, it was expected that the power prover would show higher indications than the Orsat during the distillation period. This proved to be the case and as the fuel approached the charcoal phase the power-prover indications came more nearly to the charcoal curve. In other words, during the distillation period, when the percentage of combustible gases was high, the power-prover indications were higher than the Orsat, but after the charcoal phase has been reached the indications were reversed. It is to be noted that CO is never completely absent. The power prover indicated a large reduction of the combustible gases between the magazine and the secondary combustion space.

The ultimate analyses of various woods show remarkable uniformity (see Table 3) when deciduous woods are in one group and conifer woods are in another. Heat values on a dry basis will show the same agreement. Moisture may vary from 30 to 50 per cent in green woods, depending for any species upon whether it is cut in winter or in summer. Air-dried or air-seasoned wood has a moisture content between 15 and 25 per cent. Kiln-dried wood may have from 8 to 12 per cent and really bone-dry wood may have only a brief existence as such in the fuel-testing laboratory. In the burning process the moisture must be driven off prior to distillation and ignition and the amount is large enough to cause trouble if the flue-gas temperatures are too low. If the flue temperature goes below about 150 F at the heater outlet, one may look for condensation in the smoke pipe unless the smoke pipe is five feet or less in length. If the heater is employed for garage heating, the lower ambient air temperature may cause condensation sooner.

In regard to the heat value of the fuel it should be particularly noticed that a calorimetric determination is essential. Du Long's formula seems invariably to afford a lower value. It is a sufficiently accurate generalization to say that wood is a substance in the nature of a carbohydrate while other fuels are in the nature of hydrocarbons. While the chemical formulas for wood (lignin and cellulose) are complex, it is reasonable to say that inclusion of the oxygen in the wood does not make the available hydrogen, (H — O/8) in Du Long's formula, acceptable.

TABLE 3 ULTIMATE ANALYSES, DRY BASIS

(From various government publications)

Wood	Carbon	Hydrogen	Oxygen	Ash
Ash, white	49.73	6.93	43.04	0.30
Beech	51.64	6.26	41.45	0.65
Birch, white	49.77	6.49	43.45	0.29
Elm	50.35	6.57	42.34	0.74
Hickory	49.67	6.49	43.12	0.73
Maple	51.55	6.61	41.28	0.56
Oak, black	48.78	6.09	44.98	0.15
Oak, red	49.49	6.62	43.74	0.15
Oak, white	50.44	6.59	42.73	0.24
Poplar	51.64	6.26	41.45	0.66
Cedar, white	48.80	6.37	44.46	0.37
Cypress	54.98	6.54	38.08	0.40
Fir	52.32	6.42	41.23	0.30
Hemlock	52.38	5.91	41.23	0.48
Pine, pitch	59.00	7.19	32.68	1.12
Pine, white	52.55	6.08	41.25	0.12
Pine, yellow	52.06	7.02	40.07	0.31

At the same time it is reasonable to classify wood as a high-volatile fuel. The problem of burning the gases by means of secondary air calls for the exercise of known combustion practices. At rapid rates of burning the gases can be burned with comparative ease, but at the very low rates of burning, involved in the present tests, a real problem exists relative to the burning of the heavy wood tars and creosote. Inspection of the internal flue surfaces of both heaters revealed no appreciable deposits of tar coke such as are usually associated with incomplete combustion of these products.

It is customary to divide the burning stages of a high-volatile solid fuel as follows: (*a*) drying; (*b*) distillation of volatile matter, and (*c*) burning of solid, carbonized residue. When small quantities of fuel are being constantly supplied (i.e., pulverized-coal burning) all of the foregoing events are concurrent. But when a fuel is stored in a heated space (i.e., the fuel magazine of heaters *A* and *B*), the course of events is not so certain. For example, if the fuel-burning rates are comparatively high, the several stages do occur in successive stages with a certain underlying rate of charcoal burning taking place constantly. It is a fact that a rather large volume of charcoal may be found in the fuel magazine after distillation is finished. (A clear, not smoky, atmosphere in the fuel magazine indicates that distillation has ceased.) An interesting phenomenon may take place in such cases. At 400 F or higher an exothermic reaction may set in which is not dependent upon any supply of air whatever. The heat thus generated within the wood itself aids in a more rapid evolution of volatile gases. It is not implied that this action is desirable, since it may involve the necessity of burning the gases at a rate higher than the space-heating load requires. When the exothermic reaction takes place the evolution of volatile gases goes on with vigor and later this evolution ceases abruptly, leaving only charcoal as the source of heat. Large quantities of carbon monoxide will still be formed in the fuel magazine and use of secondary air can never be omitted.

It appears that at slow rates of burning the several stages of burning may be going on at once, probably in different layers of the fuel mass. This is more desirable and will apparently produce a more uniform heat output without requiring draft manipulation. See Fig. 8 (life-history curves).

The possible products of distillation given in Table 4 will give some idea of the complexity of wood burning. For example, there is a possibility of the liberation of CO_2 which may not be associated with the burning process in the commonly understood manner.

Finally, one other reaction may be present at times, namely, the water-gas reaction. It is possible that the moisture driven from the wood may, upon being forced down into the combustion zone, on its way to the secondary combustion space, react with heated charcoal to produce hydrogen and carbon monoxide. At rapid rates of burning it is also possible that moisture may be driven from the inner portions of the wood out through the external layer of glowing carbon which is virtually a layer of charcoal. This reaction, if present, does not add anything by way of total heat of combustion but it does change the character of the combustion by introducing more combustibles in the gaseous form. This additional heat in the secondary combustion space might help to break down and burn the heavier volatile vapors.

The most unique fact, as revealed by the Orsat analysis, is that carbon monoxide seems almost never to be absent regardless of the percentage of excess air. With other fuels the presence of carbon monoxide is almost always associated with low excess air. Verification of this may be found.[2] In Table 3, p. 690, of the paper only three out of fifteen entries of carbon monoxide are reported as zero. The carbon dioxide percentage was in some instances high and in others low. In Table 7, p. 693, a mixture of tan bark and coal showed a much lower percentage of carbon monoxide than those tests with tan bark alone. It is assumed that the gas absorbed in the carbon-monoxide pipettes of the Orsat was in fact carbon monoxide. However, a verification of this should be a definite part of any future work. Because of this apparent presence of carbon monoxide at all times, it becomes apparent that the power prover previously mentioned cannot be used, since its accuracy requires that the excess air be held within fairly close limits.

TABLE 4 PRODUCTS OF WOOD DISTILLATION (JUPTNER)

1 Hygroscopic water
2 Gas, consisting mainly of
- (*a*) Acetylene
- (*b*) Ethylene
- (*c*) Benzol
- (*d*) Naphthalene
- (*e*) Carbon monoxide
- (*f*) Carbon dioxide
- (*g*) Methane
- (*h*) Hydrogen

3 Liquid tar, consisting of
- (*a*) Benzol
- (*b*) Naphthalene
- (*c*) Paraffin
- (*d*) Retene
- (*e*) Phenol
- (*f*) Oxyphenic acid
- (*g*) Crysylic acid
- (*h*) Phlorylic acid
- (*i*) Creosote $\{C_7H_8O_2, C_8H_{10}O_2, C_9H_{12}O_2$
- (*j*) Resins

4 Pyroligneous acid, consisting of
- (*a*) Acetic acid
- (*b*) Propionic acid
- (*c*) Acetone
- (*d*) Wood alcohol

5 Wood charcoal

Considering the combustion stages already discussed, it becomes apparent that a heat-loss determination, based on average values for the whole test, lacks accuracy from an academic standpoint at least. Since the moisture may all come off during the first part of the test, the loss due to moisture in the fuel ought to be associated with the flue temperatures existing at that time. During the gas-burning interval the same question relative to the hydrogen loss arises. The heat value per pound of combustible consumed should also be quite different than the values existing during the charcoal phase.

Since the fuel is constantly changing in character, it follows that the carbon-monoxide loss during the charcoal stage and the weight of dry flue gas ought to be associated with the then-existing percentage of carbon in the fuel which is considerably higher than the ultimate analysis of the original wood. When it is considered how variable a product charcoal itself can be (see Table 5), it becomes apparent that the difficulties of breaking down heat-loss calculations to conform to the stages of combustion may remain an academic problem for some time.

In conclusion, the performance of the heaters shows that good efficiencies may be obtained with long firing periods. More attention is needed in the matter of flue-gas analysis, but it must be pointed out that the addition of a combustion pipette will not be operative on the heavy, condensable vapors and acids.

Heater *B* represents a departure in American practice and the problem of management by the user will require instruction in a new technique. The outstanding advantages of heaters of this type are the freedom from constant attendance and more uniform heating service throughout the entire 24 hours.

TABLE 5 ANALYSIS OF CHARCOALS FORMED AT DIFFERENT TEMPERATURES

Distillation temp, F	Carbon, per cent	Hydrogen, per cent	Oxygen, per cent
392	52.3	6.3	41.4
482	70.6	5.2	24.2
572	73.2	4.9	21.9
752	77.7	4.5	18.1
932	89.2	3.1	6.7
1112	92.2	2.6	5.2
1292	92.8	2.4	4.8
1472	95.7	1.0	3.3
1652	96.1	0.7	3.2
1832	96.6	0.5	2.9

TEXTILE DRYING

A Review of Recent Developments

By FRED KERSHAW

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THE drying of textiles is a big subject and cannot be adequately covered in thirty minutes. Because there is a vast variety of textile fibers and fabrics, and literally hundreds of different treatments and processes through which these materials are put, it is necessary for the industry to make use of many forms and types of driers. Consequently, it will be impossible adequately to describe all of these various types of driers or to cover the subject of textile drying completely. Hence this paper will be confined to a quick résumé of the high lights of the outstanding improvements recently made in driers for textile fibers and materials.

AUTOMATIC RAW-STOCK DRIER

To illustrate the advancement recently made in textile driers, one of the widely used drying machines, the automatic raw-stock drier, will be described. This machine is used (with slight variations in details of construction) for the drying of dyed or bleached cotton raw stock, cotton linters, cut rayon staple, wool in the grease, scoured wool, and mixtures or combinations of these fibers.

To give an idea of the improvement recently made in this type of machine, it is only necessary to point out that whereas not so many years ago it required about 10 min to dry dyed cotton in an automatic drier, today in the most modern type of raw-stock drier dyed cotton is being dried in $1^1/_4$ min, about one eighth the former time. The capacity has been increased 50 per cent over the most recent stock driers and more than 100 per cent in the case of the older types. This, of course, means a great increase in capacity per square foot of floor space, and in many instances the cost of erecting an extra building or an addition to a building has been obviated by the installation of a modern machine of this kind to replace one of an older design, when increased capacity was necessary. In one case, a modern drier of this type replaced a drier only 15 years old. During the first year's operation the savings effected paid for the installation three times over. Similar favorable results have been reported in the woolen, cotton-linters, and staple-rayon industries.

Another advantage of the quick drying time of this modern raw-stock drier is that the stock is in the heat only about one eighth of the time formerly necessary. As a consequence it has been found that the dried cotton is in a much better condition than when dried in the older types. The modern raw-stock drier is also a clean machine as compared to some of the older types. Much less stock is blown around inside the machine and, therefore, cleaning of the machine either between lots or at the end of a run is much simpler and quicker. All of this helps to increase the over-all capacity of the drier, because the shut-down time for cleaning and maintenance is reduced.

To attain this increased production, better quality of the dried stock, and greater cleanliness of the machine, practically every feature of the older types of machines was discarded, and a completely new development worked out. For instance, an entirely new automatic feed was developed, not only because there was a speed limitation of the type of feed formerly used, but also because the maintenance cost on the old type of feed was entirely too high. The modern drier uses what is termed a rotary drum feed, Fig. 1. Wet cotton is thrown or blown into a hopper in which a 48-in diam spike drum revolves, which picks up the wet cotton and deposits it onto the drier conveyer. This development was necessary because of the increased capacity the automatic self-feed is now called upon to deliver to the drier. The life of this feed should be much longer and the maintenance cost much less than was the case with older types of feeds.

Another feature of the modern raw-stock drier that has helped to increase the production and cut down the drying time is the method of creating and controlling the air circulation. A special type of motor-driven turbine fan was developed. The fan is mounted directly on the motor shaft without a coupling or extra bearing, Fig. 2. The end of the motor is extended so that the bearing is close to the fan without any undue overhang. A small fan inside the motor circulates room air around the inner

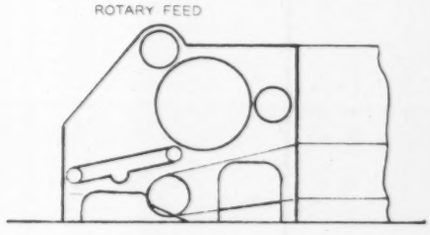


FIG. 1 ROTARY DRUM FEED FOR RAW-STOCK DRIER

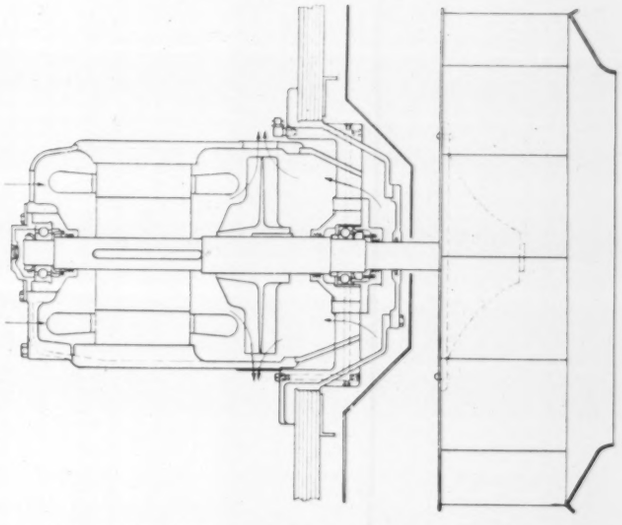


FIG. 2 MOTOR-DRIVEN TURBINE FAN FOR RAW-STOCK DRIER

Contributed by the Textile Division for presentation at the Annual Meeting, New York, N. Y., Dec. 2–6, 1940, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

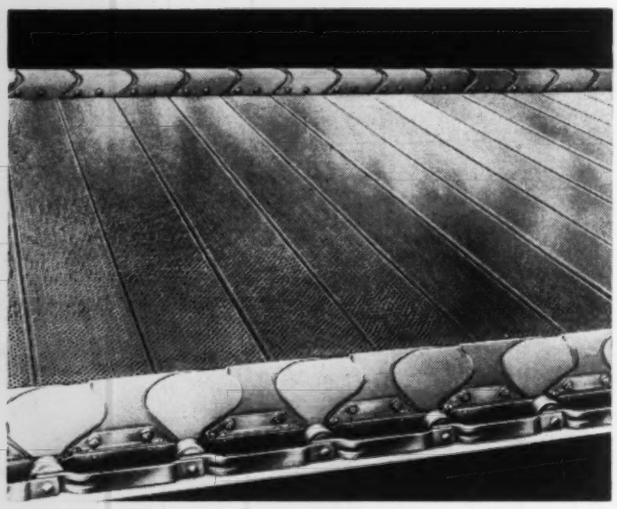


FIG. 3 PERFORATED-PLATE CONVEYER FOR RAW-STOCK DRIER

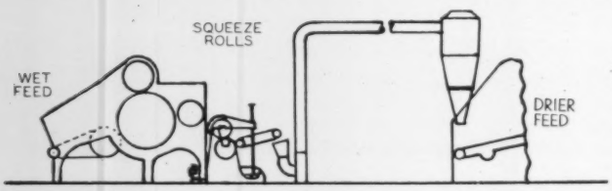


FIG. 4 SQUEEZE ROLLS AND FAN CONVEYER BETWEEN DYEING MACHINE AND DRIER

bearing so that it is always kept at room temperature. By using turbine fans and direct motor drives it has been possible to confine the air travel in a restricted and well-defined path, and to obtain high velocities through the stock at higher static pressures than was possible with the old-style disk fans. In many of the older types of driers the fans were driven by belts and pulleys from countershafts. Use of direct motor drives has eliminated loss of production which came about through the slippage or breakage of belts and belts jumping off pulleys.

In its passage through the modern drier the cotton is hit by successive jets of high-velocity air. Between these jets there is a region of lower pressure, which allows the cotton to relax. The net result is that the stock in its passage through the drier has a breathing action which, apparently, is beneficial.

The conveyers used for carrying the cotton through the drier have undergone a radical change. Woven wire screen has been replaced with perforated metal plates. The plates are stronger and keep cleaner than the wire screens, and although they are more expensive, the ultimate cost is less because replacements are required less frequently and the attendant loss of production while installing new screens is reduced.

In the perforated-plate conveyer illustrated in Fig. 3 the adjoining plates are connected to each other in the form of a fine hinge. This joint is made by stamping small slots along the entire edge of the plates and bending the edges in a semicircular form. The adjoining plates dovetail into each other and are held together by a stainless-steel wire. No extra pieces are riveted or welded onto the perforated plate. Therefore, there is nothing to come loose and no place for the stock to get caught. There are also no obstructions to the air flow through the cotton and yet the joint is so fine there is no more droppage of cotton through the joint than there is through the perforations in the plates. Because the plates are joined together they are not distorted. The conveyer surface is always smooth and flat. The cotton rests on the conveyer in a uniform layer and there is no chance for the cotton to drop through the joints between adjacent plates.

Vertical guards are fastened to each side of each perforated conveyer plate. These metal guards travel with the conveyer and prevent the material from falling off or getting into the chains and other parts of the drier.

Each perforated plate is individually fastened to a long side bar of the conveyer chain. The entire load is taken by the chain, so that the perforated plates are under no strain whatsoever. The chain is a heavy, die-stamped, steel chain equipped with large rollers which run on hardened steel bushings and stainless-steel pins.

The new stock drier is also tighter and better insulated than older driers. Doors and panels on the housings of these driers are now constructed in such a way that the structural framework of the drier is completely covered with the insulated panels or doors. The panels and doors are filled with a heavy semirigid bat of rock wool, and a thick resilient air seal is incorporated in the edges of all doors and panels to prevent leakage of hot air. The air seals are made of cork with asbestos thread braided over the entire surface. The better insulation and the tighter panels and doors result in a saving of steam and the ability to maintain maximum temperatures with the steam available.

Another development which has been recently perfected in connection with the use of raw-stock cotton driers is the application of squeeze rolls instead of centrifugal extractors for removing surplus water from the stock before drying. See Fig. 4. The use of squeeze rolls places a slightly greater burden on the drier, because they do not remove as much moisture from the stock as centrifugal extractors do, but the saving in labor is an advantage. Wet stock from the dyeing machine is placed in the hopper of the self-feed in front of the squeeze rolls and is blown from the squeeze rolls through a fan to a cyclone over the self-feed of the drier. This makes it possible to place the squeeze rolls in the dye house close to the dyeing machine, because the stock can be blown to the drier in any other part of the building.

IMPROVEMENTS IN YARN AND WARP DRIERS

Improvements have also been made in driers for yarn—yarn in skeins, mercerized warps, dyed warps—and in the preparation of cotton warps for weaving.

In the drier for skein yarn a recent development increases the productive capacity of the drier, and at the same time prevents snarling and damage. This development is a protector or skirt which travels with the skeins of yarn as they pass through the drier and prevents them from touching or rubbing against the

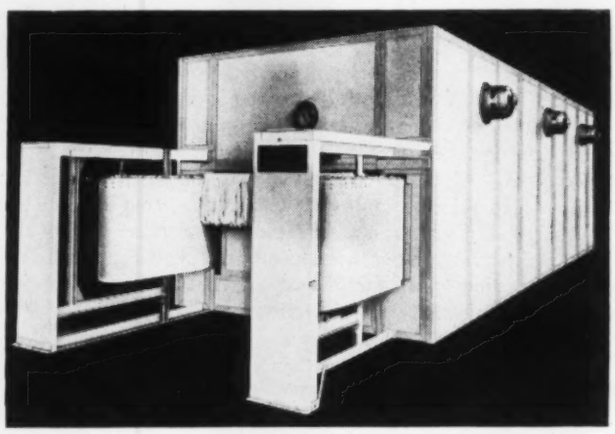


FIG. 5 TRAVELING PROTECTORS APPLIED TO SKEIN DRIER

sides of the machine, Fig. 5. The use of this traveling protector permits the loading of the skeins out to the ends of the poles. In older types of driers a space of 12 to 18 in. was left bare at each end of the pole to avoid the possibility that the end skeins would rub against the structural work of the drier. This empty space was bad for two reasons, first, because of the loss of holding capacity, and second, because it left open spaces through which the circulating air could by-pass without any restriction, thereby reducing the velocity and volume of the air that actually went through the skeins. The modern automatic yarn drier with the traveling protector is able to dry a great deal more yarn for a given length than older machines not so equipped.

For drying packages of yarn dyed in package-dyeing machines a drier has been developed, which is equipped with reversing air circulation, with temperature and humidity controls, steam sprays, and automatic exhaust dampers, Fig. 6. The circulation of air is reversed at predetermined intervals so as more uniformly to dry the packages from top to bottom. The automatic exhaust damper and steam sprays are operated by humidity controls so that the circulating air never becomes dry enough to make the yarn on the outside of the package harsh.

Until a few years ago mercerized cotton warps were dried on cans or cylinder driers. Now, practically every mercerizer in the country is equipped with one or more rolling festoon driers, Fig. 7, in which the warp is dried by heated air instead of direct contact with heated metal surfaces. The result of the use of this drier has been a more elastic yarn, a rounder yarn, and a fuller count.

A sheet of warp is fed directly from the mercerizer over a compensating roll into the rolling festoon drier, where it is looped over revolving poles. As each loop is formed, a loose pole from a magazine overhead is automatically fed into the bottom of the loop. As the conveyer moves along the length of the drier, both top and bottom poles are revolved, and the warp, therefore, moves both up and down and forward at the same time. The warp never stays in contact with the pole at any one spot. As the warp shrinks in drying the vertical distance between the poles diminishes, thus avoiding any strain on the warp. At the end of the drier, as the last loop is pulled out of the machine, the roll in the bottom of the last loop is automatically removed and deposited on a small separate conveyer which carries it back to the pole magazine feed at the front end of the drier. The dry warps are then split and plaited down into trucks.

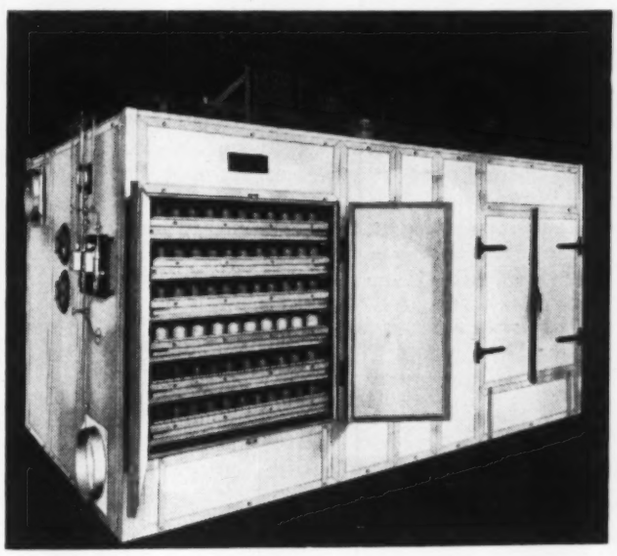


FIG. 6 MACHINE FOR DRYING PACKAGES OF YARN

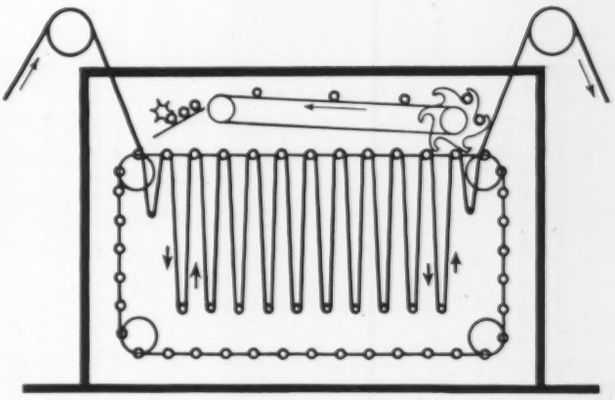


FIG. 7 ROLLING FESTOON DRIER

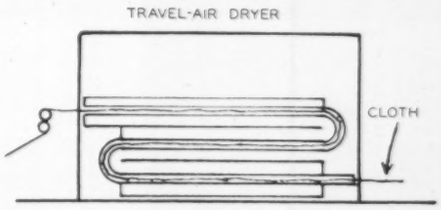


FIG. 8 AIR CONVEYER FOR PIECE-GOODS DRIER

PIECE-GOODS DRIERS

Space will not permit an adequate discussion of all the different types of driers for piece goods. The loop drier, which has been in use for many years, has been modernized so that today it is equipped with direct motor drive, air looper, rotating girts, variable girt rotation, and control. The capacity of this machine has been increased by the use of more efficient fans and heaters and by a better control of the air flow.

In another piece-goods drier, which is at present in the experimental stage, the cloth is conveyed by the air stream, Fig. 8. There is nothing essentially new in conveying by air, but the problems involved in finding a method of precisely controlling the air currents have been difficult to solve. In operation this drier feeds itself as fast as the metering rolls at the feed end will permit. Adequate circulation is provided on both sides of the cloth. Therefore, there is no tendency toward shading, which is troublesome with certain types of dyes and finishes. Furthermore, with no continuous contact with any surface there is no marking of finished goods. Not enough commercial data are available to estimate the value of this machine properly.

The fastest commercial drying machine at present in operation for piece goods is the straight-run high-speed tenter, Fig. 9. In this machine, because of extremely high air velocities, five-yard cotton piece goods can be dried in approximately 10 sec.

Another interesting drier under development is shown in Fig. 10. Piece goods going through this drier are held in a series of small loops between two conveyers. Air jets blow on both sides of the goods so there is an absence of shading. A possible use of this machine, which has not as yet been demonstrated fully, is for shrinking. Thus far the residual shrinkage of the cloth running on the experimental machine has been reduced to a very small amount.

Another new development in driers is shown in Fig. 11. This machine is used for drying washed rugs. It is wide enough to take a rug 17 ft wide. The washed rug, after being

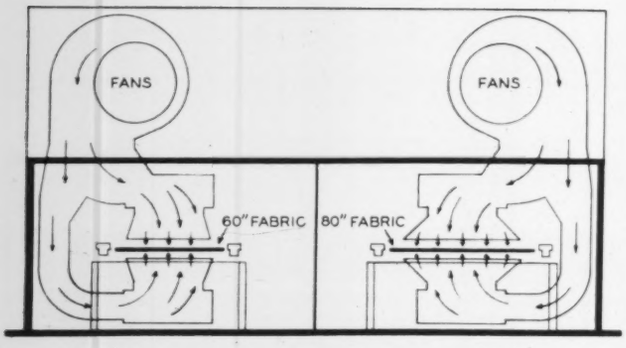


FIG. 9 STRAIGHT-RUN HIGH-SPEED TENTER

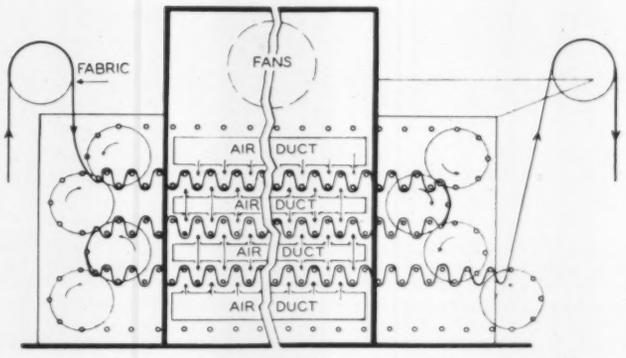


FIG. 10 PIECE-GOODS DRIER UNDER DEVELOPMENT

thoroughly rinsed with water, is lined up and fed through squeeze rolls, from whence it is automatically carried through the size rolls where an even coating of cold-water size is deposited on the back of the rug. Leaving the sizing rolls, the rug is picked up automatically by the main conveyer of the drier. A soft rubber roll presses the rug down on small pins in the main conveyer. These small pins, which are not unlike victrola needles, hold the rug over its entire area and prevent shrinkage during drying. As the rug travels through the drier, high-velocity jets of air impinge on both sides and the rug is dried horizontally as it would lie on the floor. The natural tendency of the rug to shrink results in a tentering effect and produces a finished rug, the equal of a new rug in body and floor-holding qualities. Whereas in the average rug-cleaning plant a drying time of 15 hr is required, in this machine a drying time of only 15 min is necessary.

POSSIBLE FUTURE DEVELOPMENTS

In such a discussion as this, it is interesting to look forward to developments that may become available in the future. Recently, interest has been aroused in the possibilities of drying by means of infrared radiation. Reduced to its simplest form, this merely means drying with radiant heat instead of heated air. For any substantial amount of heat energy to be transferred by such radiation the radiant member must be at a high temperature, such as the filament of an electric-light bulb. To a large degree, heat is transferred from the hot filament to the object to be heated without materially heating the air between the filament and the object. Air movement is unnecessary in this type of heat transfer, although it may be necessary to have just enough air velocity to remove the surrounding air, which becomes saturated with the evaporated water.

Drying by infrared radiation is best suited to very thin filaments where the heat must not penetrate to any considerable depth, and to painted surfaces, where any substantial movement of air would convey dust particles to the paint.

The heat radiated to the surface of the material from infrared lamps must penetrate by conduction. There have been, and will continue to be, many misapplications of this type of drying, because of misunderstanding of these qualities. The development of suitable reflectors has, however, been one of the most important modern advances. If operating and maintenance costs are not important factors, the field of infrared radiation drying can be increased, but it will probably cost about five times as much to evaporate a pound of water by this method, as it would with conventional steam coils.

A combination of both forms of heat may be possible in some cases, but every instance seems to be an individual problem, of which an intelligent study must be made in order that the best result may be obtained at the least cost. It appears, however, that the widest field of drying with the infrared lamp is that of drying painted surfaces.

Drying by means of the passage of high-frequency electric current through the material to be dried has not been widely publicized. The high-frequency current with its extremely short wave length has a tremendous penetrating effect. In its alternating passage through the material to be dried, molecules are displaced and by their movement heat is generated. Unlike infrared rays, which do not penetrate the surface, the high-frequency current penetrates the object and heats from the inside. Essentially, we may think of this as an ordinary electric circuit, in which the passage of current is generating heat owing to the resistance of the circuit. As the material dries out evenly or in sections, the resistance is increased and the current passage reduced. This reduces the heating effect in the dried sections in much the same manner as a decrease in current decreases the heating of an ordinary circuit. At the present time, it appears that the use of high-frequency drying in the textile business will not be practicable for a long time to come. The first cost of the high-powered equipment required in commercial installations is excessive, owing to the extremely high cost of the power tubes and allied equipment. In both methods of drying by electricity (infrared and high frequency) there are three basic limitations: First, the great concentration of power necessary to evaporate the large amounts of water required in the commercial drier make the first cost of equipment in both cases extremely expensive. Second, the present life of lamps and tubes is only 5000 hr, which means that these items would have to be replaced in one to two and a half years. Third, basic cost of evaporation is approximately five times that by steam.

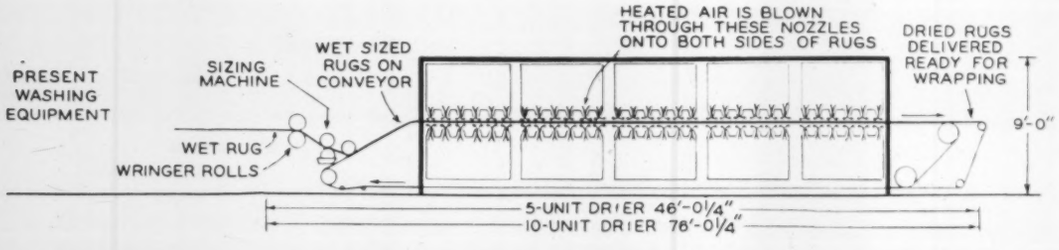

HEATED AIR IS BLOWN THROUGH THESE NOZZLES ONTO BOTH SIDES OF RUGS
DRIED RUGS DELIVERED READY FOR WRAPPING
WET SIZED RUGS ON CONVEYOR
SIZING MACHINE
PRESENT WASHING EQUIPMENT
WET RUG WRINGER ROLLS
9'-0"
5-UNIT DRIER 46'-0¼"
10-UNIT DRIER 76'-0¼"

FIG. 11 DRIER FOR WASHED RUGS

Progress in RAILWAY MECHANICAL ENGINEERING, 1939-1940

1 GENERAL CONSIDERATIONS

THIS report covers approximately the period from August, 1939, to August, 1940. It is difficult to set up a general characterization of the period. In America a rapid increase in traffic brought in orders for new equipment at an accelerating pace. In Europe preoccupation with war conditions and wholesale overturning of existing governmental organization has resulted in our being able to review comparatively few reports of progress. Some general factors will first be considered:

LOCOMOTIVE OBSOLESCENCE

At the beginning of 1940 there were 43,300 locomotives nominally in service, of which 28,700, or 68 per cent, were "of age," that is, 20 years old or more. There are only 2400 locomotives in service less than 10 years old, and during the five-year period in which the "of age" percentage has increased from 58 to 68, only 1200 locomotives have been added to the "youthful" end of the inventory. This is of particular importance in view of the tendency in both freight and passenger service toward increasing speed. It is worth noting that this and last year have seen the considerable number of locomotives built during the last war pass into the "of age" class, which emphasizes the well-known facts of intensive utilization and high-mileage requirements of the newer engines.

SPEED-UP IN FREIGHT SERVICE

The acceleration of merchandise freight service previously mentioned in these reports has continued until it may be thought of as one of the characterizations of the year. From every major and numberless minor terminals the country over, the end of the business day sees these "mainliners," "flagships," "hotshots," ready to set out on passenger schedules to make possible merchandise deliveries at points from three to six hundred miles distant in time for next-morning opening of business. The principal contributing factors from an engineering standpoint are the use of high-wheel locomotives with boiler capacity to sustain power at high speeds, usually 4-8-2's, 2-8-4's, or 4-8-4's, not to omit articulated simples and Pacifics, many of the locomotives being pooled with passenger runs and used alternatively; also freight cars with modernized trucks and spring arrangements, the AB brake, and, in general, designs worked out to limit tare weight as far as possible. For main-line service it seems that the "drag-freight era" is well on its way out, along with archbar trucks, 63-in. drivers, and cars which cannot carry three times their weight or more.

FAIR EXHIBIT

At the New York World's Fair the "Railroads on Parade" spectacle, which drew 1,300,000 paying customers last year, continued to show to full houses several times a day. The "Railroads at Work" model show of last year was materially increased, and, as "Railroads in Action," has been "packing them in." The great railroad diorama and the yard exhibit are substantially the same as for the first year show. The *Coronation Scot* has been in its accustomed place and will, it is understood, be stored in this country until sea transportation is again safe. And the Sl 6-4-4-6 locomotive has made its mileage on the roller mountings.

SPEED

The limit for normal equipment seems to be temporarily pegged at 126 mph or about 202 kmph. An Italian electric train running on a slightly descending grade attained this figure, which was also the momentary record of the steam locomotive *Mallard*, and the same speed is claimed for a German streamlined 4-6-4. The 143-mph figure of the propeller-driven Kruckenberg "rail Zeppelin," which incidentally had more than 30 hp per ton of weight, has not been more closely approached by conventional equipment.

ORDERS FOR EQUIPMENT

Orders in 1939 included 95 steam locomotives, 32 electric locomotives, and 248 Diesel-electric or other internal-combustion engine locomotives. The division of the steam locomotives by wheel arrangement is instructive:

28	4-8-8-2 articulated simples (same actual wheel arrangement but
12	2-8-8-4 articulated simples (oil burners run cab-ahead.
10	2-8-8-2 Mallets
25	4-8-4
8	4-8-2
2	2-8-4
3	2-8-2
2	0-8-0
5	2-6-0

Thirty-six steam locomotives were ordered for export, all of which went to South America, and 56 locomotives were ordered in Canada. The figures for the year covered by this report are as follows:

Steam locomotives, 158, including only 4 for switching service
Diesel-electric switchers, 131
Diesel-electric passenger locomotives (streamliners), 14
Electric locomotives, 20
Freight cars, 37,173
Passenger cars, 226.

During 1939, 20 new streamline trains went into service. Those placed in schedule service from the last report to the closing date of the present report include the following:

Chicago & North Western: 2 *400* trains, 10 revenue cars each.
Rock Island: 2 Rocky Mountain *Rockets*, 10 revenue cars each.
Seaboard: 2 *Silver Meteor* trains, 7 cars each.
Atlantic Coast Line: 2 *Champion* trains, 7 cars each.
Florida East Coast: 1 *Champion*, 7 cars.
Missouri Pacific: 2 *Eagle* trains, 6 revenue cars each.
Southern Pacific: 2 *Daylight* trains, 14 revenue cars each.
C. & N. W., U. P., S. P.: *City of San Francisco*, 14 cars.
C. & N. W., U. P.: *City of Los Angeles*, 14 cars.
Milwaukee: 2 *Hiawatha* trains, 9 revenue cars each.

The *Daylight* and *Hiawatha* trains are handled with steam power, the others by Diesel-electric locomotives.

On Oct. 2, 1939, the *Pioneer Zephyr* of the Burlington ran

Report of Committee RR6, Survey, contributed by the Railroad Division for presentation at the Annual Meeting, New York, N. Y., Dec. 2-6, 1940, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Report prepared by the Chairman, E. G. Young, with cooperation of members of the Committee, Messrs. B. S. Cain, K. F. Nystrom, and John Roberts.

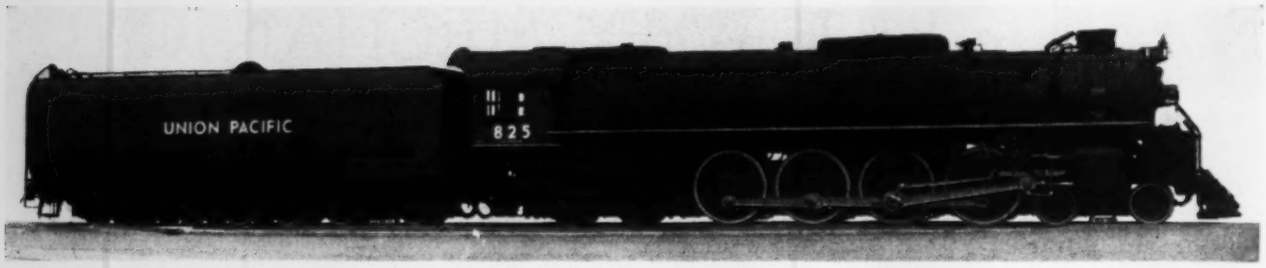


FIG. 1 4-8-4 FOR UNION PACIFIC

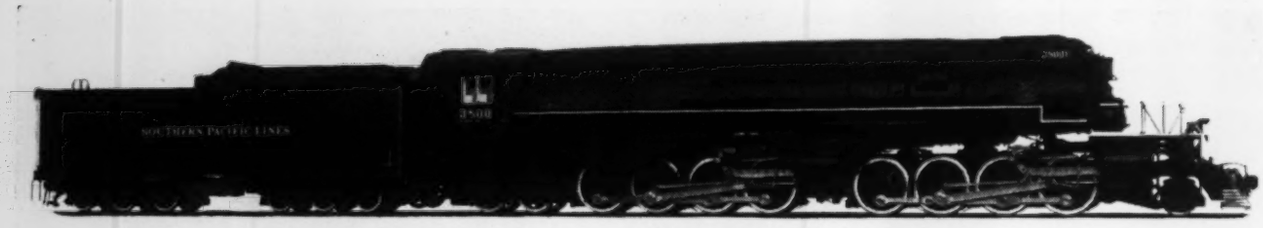


FIG. 2 SIMPLE ARTICULATED 2-8-8-4 FOR SOUTHERN PACIFIC

FIG. 3 2-8-4 FOR NORFOLK SOUTHERN

through an open switch at a speed estimated variously at 45 to 60 mph, and collided with a steam locomotive on the siding. This was the first major accident involving a train of the stainless-steel type. The front end of the *Zephyr*, containing the engine, was crushed, the second car sustained minor structural damage, and the two rear cars were practically uninjured. The cromansil engine bed assembly was checked and realigned. Cab-floor parts were renewed and the entire bed then sent to the Budd Company at Philadelphia, where 28 ft of new car body and front-end shell was built around it.

Owing to the tilting of the generator the Diesel crankshaft was sprung. The engine main generator and the other power plant and cab accessories were repaired at the Electro-Motive Corporation's plant, and the apparatus was reassembled in the railway's Aurora shops. The entire new front end of the power car was spliced to the salvaged and repaired rear end of the original car by spot welding, using lap reinforcement pieces on stress-bearing members. The train was returned to service on Dec. 6. The railway's estimate of damage to the streamliner was $60,000 of which $29,000 was for the body of the first car and $25,000 for the power plant.

A notable record of dependable performance was completed when on Feb. 25, 1940, B. & O. Diesel-electric locomotive No. 56 made a record of 100 per cent for 12 months, completing its 365th consecutive daily trip from Chicago to Washington, or vice versa, 772 miles per day, a total of 281,780 miles. The longest period during the year for which it was idle was $6\frac{1}{2}$ hr. The locomotive is a two-unit 3600-hp engine built by the Electro-Motive Corporation in 1938.

An example of locomotive modernization of exceptional interest is that of Mikados on the Minneapolis & St. Louis. These locomotives were given new tenders with enlarged coal and water capacity, and the increased height of center of gravity made necessary a steady connection between locomotive and tender which was secured by the use of Franklin E2 buffers. Boosters were added. Locomotive mileage has been increased from 3000 to 7000 miles a month, train load by 100 tons, and the speed has been nearly doubled, as part of the contribution of the locomotives to helping this railroad operate at a profit.

The Missouri Pacific effects economies with an auxiliary water car. A standard 10,000-gal tank car, refitted at cost of $490, substitutes for new high-capacity tenders costing $15,000 to $18,000, saving in fuel and the elimination of several water stations including some at which treatment was most costly and least successful.

Three passenger cars of the "pendulum type"[1] are under construction, one each for the Santa Fe, Burlington, and Great Northern. It is proposed to operate the three cars as a single train for test purposes. The general construction and principles of this type of car were explained in a previous report in this series. Presumably the present cars will be built with

[1] See "A Fundamental Development in Suspension and Construction for Railroad Cars," by P. K. Beemer, F. C. Lindvall, E. F. Stoner, and W. E. Van Dorn, MECHANICAL ENGINEERING November, 1940, pp. 779–784.

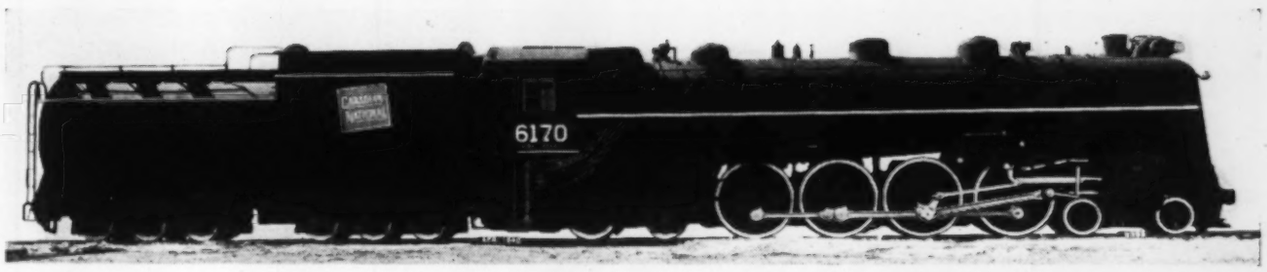


FIG. 4 4-8-4 FOR CANADIAN NATIONAL

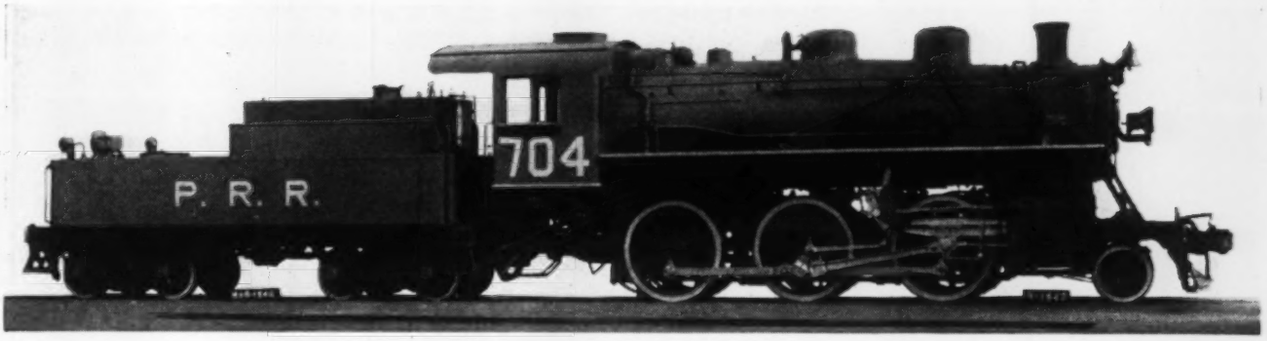


FIG. 5 2-6-0 FOR PANAMA RAILWAY

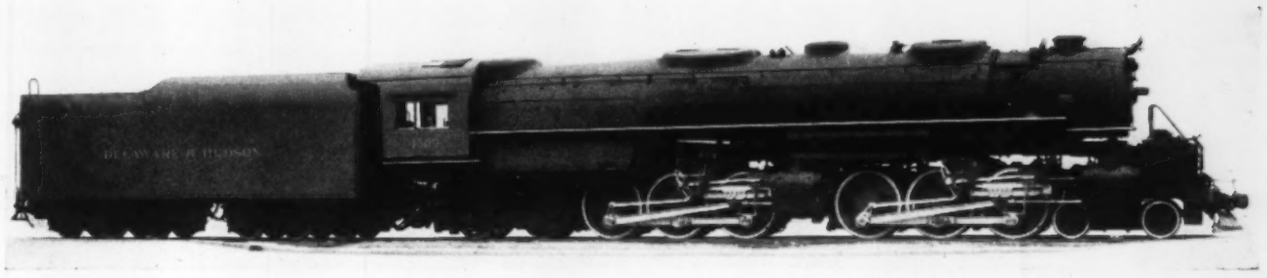


FIG. 6 SIMPLE ARTICULATED 4-6-6-4 FOR DELAWARE AND HUDSON

metal sheathing in place of the plywood construction of the original sample car. The cars are constructed by the Pacific Railway Equipment Company.

Three research reports were issued by the office of the mechanical engineer, Division V, Association of American Railways:

1 "Final Report on Failures and Performance of Main Crank Pins on Steam Locomotives" shows that such failures are relatively more important and numerous in locomotives operating at sustained high power and speed, and stresses the desirability of dividing the steam thrust between the pins on two pairs of drivers, in order to keep the pins within reasonable size and fiber stresses within 15,000 psi. The life expectancy of a crankpin is probably increased by the use of the utmost care in machining, and analogous investigations indicate that either cold-rolling or flame-hardening of the wheel fit of the pin are promising possibilities, as more failures occurred in the wheel fit than at any other place. The report also points out the advisability of setting a maximum mileage before renewal, making no recommendation except that each railway must set its own limit. The average mileage before renewal of replaced pins was about 110,000. This included pins removed because of failure, reaching wear limit, and cracked on inspection.

2 "Fourth Progress Report on $5^1/_2 \times 10$ Passenger Car Axles." This report deals with the influence of design on fatigue strength. A new design of axle eliminating the back collar and increasing the diameter of the wheel seat is recommended. Conclusions on axle material are deferred until more tests have been made on normalized and tempered axles. It was found that the fatigue strength of axles turned down from larger sizes was only slightly less than those machined from proper forging sizes. Dimensions for two new standard axles were proposed, these having journals 7×13 in. and $7^1/_2 \times 14$ in., respectively.

3 "Tests of Trucks for High-Speed Freight Service." This publication reports tests on eleven different trucks designed for high-speed freight service, compared with a standard A.A.R. spring plank truck equipped with plain coil springs. Each truck was tested with four different rail loads and with concentric and eccentric wheels, respectively. Some of the facts developed are reported thus: Spring snubbers found useful in reducing oscillation at speed up to 60 mph are definitely detrimental to the spring action at the 85-mph speeds standard in these tests. Their presence in the spring system makes the latter more sluggish, whereas the liveliness and sensitiveness of the spring system is the major consideration in high-speed operation. Soft springs are the real solution of the high-speed truck problem and the softer they are the better the results secured, but with the soft springs sufficient lateral stability must be preserved for safety of operation. The squaring action of the truck must be preserved to prevent derailment, and even

if derailment conditions are not attained, the shocks resulting from out-of-square conditions are transmitted to the body as an element of unsatisfactory operation.

ANNUAL MEETING OF DIVISION V

In addition to the reports just mentioned, a report on intercrystalline cracks in locomotive boilers, commonly called "embrittlement," was presented at the annual meeting of Division V by Schroeder, Berk, and O'Brien of the U. S. Bureau of Mines. The paper clearly sets forth the cause of such cracking as the attack of oxidizing agents on stressed steel at high temperature, sketches a simple embrittlement detector, and shows how riveted seams are specially subject to this action. Suggestions for control include the use of welded seams and determination of water treatment which would minimize the embrittlement cracking. Attention is called to what seems a parallel development in the extensiveness of boiler water treatment for scale and sludge, and the difficulties with embrittlement.

2 DOMESTIC STEAM LOCOMOTIVES

Item 1 of Table 1 represents the second recent series of 4–8–4's bought by the Union Pacific for heavy passenger service. These are designed for 100 mph operating speed and 90 mph at full horsepower output. As compared with the previous similar locomotives, cylinders have been increased from $24\frac{1}{2}$- to 25-in. diam, driving wheels from 77 to 80 in., a type E superheater has been used in place of the former type A, and tubes and flues have been shortened from $20\frac{1}{2}$ to 19 ft. All axle journals have roller bearings. The tenders are exceptional in many ways. They have a four-wheel conventional leading truck and five axles on the rear end, mounted in pedestals cast integrally with a General Steel Castings water-bottom tender frame. See Fig. 1.

Item 2, Table I, represents a series of 12 simple articulated locomotives built by Lima for the Southern Pacific. These engines are similar in general but slightly larger than the long series of cab-ahead oil-burners built by Baldwin for the same line over the last several years. The Lima engines are coal burners with the same wheel arrangement. Dimensions which cannot escape notice include a total weight of 690,000 lb, a grate area of 139 sq ft, and a combined heating surface of nearly 10,000 sq ft. See Fig. 2.

The Norfolk Southern locomotives involve no radical departures or maximum dimensions, but employ the four-wheel trailer under the firebox in engines of moderate size and capacity. See Fig. 3.

The Milwaukee locomotives represent an addition to a class of power previously mentioned in these reports. Dimensions and proportions are generally identical with the previous engines of 1938, but there is a slight increase in weight. These locomotives are classified as freight engines.

The Montreal-built 4-8-4's (Why doesn't someone give us an apt name for this wheel arrangement?) are analogous to the Norfolk and Southerns in representing a most modern wheel arrangement in relatively moderate proportions, i.e., a total weight of 402,700 lb. See Fig. 4.

There is a particular interest in a duplication order, and while item 6 apparently represents nothing new, such a duplication is a most striking "seal of approval" on an order of engines delivered in 1936. The Baldwin 4-8-2's for the Boston and Maine also duplicate locomotives built in 1935.

The construction of a Mogul-type locomotive of modern design and proportions is news of almost the "man-bites-dog" type, but such an order was built during the year by the American Locomotive Company for the Panama Railroad. A tractive force of 28,000 lb and 63-in. drivers are adequate for the load and speed requirements of this near-water-level line. The firebox width is the maximum of $41\frac{1}{4}$ in. which can be obtained between the backs of a pair of driving wheels. See Fig. 5.

The Green Bay & Western Mikado represents a second order for moderate power locomotives to replace the 2-6-0's which moved its freight for many years. This locomotive is characterized by light driving-axle loads (51,000 lb) and heavily loaded trucks (29,500 and 51,500 lb, respectively).

Item 9 represents a new design of simple articulated locomotive, a radical departure for a railroad which has always moved its freight with consolidation locomotives. This engine has smaller cylinders but a higher working pressure than most of the previous examples of the 4-6-6-4 arrangement. See Fig. 6.

3 FOREIGN STEAM LOCOMOTIVES

Item 1, Table 2, is a 4-6-0 general-utility engine, of which the British L.M.&S. Railway now has more than 500 in service, more than 40 of these having been built during the current year. They are used in service ranging from heavy passenger trains at moderate speeds to heavy "mineral" trains. Dynamometer tests have shown average coal rates of 3.38 lb of coal and 24 lb of steam per drawbar horsepower-hour. See Fig. 7.

Several locomotive builders, as well as the Crewe shops of the railway, have constructed these engines in lots of 20 to 50. The boiler is built of 2 per cent nickel steel with the usual British copper firebox.

Item 2 is a 2-8-0 locomotive, a standard L.M.S. engine, the design of which was adopted for overseas military service by

TABLE 1 DOMESTIC AND CANADIAN STEAM LOCOMOTIVES

ITEM NO	TYPE	RAILWAY	BUILDER	CYLINDER DIMENSIONS	WORKING PRESSURE	DIAMETER DRIVERS	COMBINED TOTAL HEATING SURFACE	WEIGHT IN 1000'S ON DRIVERS	WEIGHT IN 1000'S TOTAL	RATED TRACTIVE FORCE	GRATE AREA	TENDER WEIGHT	TENDER FUEL TONS-GAL	TENDER WATER GALLONS	TENDER WHEELS
1	484	Union Pac	Alco	25×30	300	80	6370	270	483	63800	100	406.5	25	23500	16
2	2884	Sante Fe	Lima	24×32	250	63½	9749	531	689.9	104300	139.3	430.7	25	22100	12
3	284	Norfolk So	Bald	23½×30	250	63	4768	202.9	335.4	49300	80.3	200	16	14000	12
4	484	Milwaukee	Bald	26×32	285	74	7803	289	493.5	72800	106	394.5	25	20000	12
5	484	Can Nat	Mont	25×30	250	73	6104	240.8	402.7	56800	84.4	284.2	20	15500	12
6	284	D.T.&I.	Lima	25×30	260	63	7316	243.4	416	65800	88.3	344	22	22000	12
7	484	B.&M.	Bald	28×31	240	73	6435	268.4	415	67300	79	374.2	21	20000	12
8	260	Panama	Alco	18×26	250	63	2063	147	168	28400	33	110	2300	5000	8
9	4664	D.&H.	Alco	20½×32	285	69	7071	406.5	597	94400	108	391.2	26	22500	12

TABLE 2 FOREIGN STEAM LOCOMOTIVES

ITEM NO	TYPE	RAILWAY	BUILDER	CYLINDER DIMENSIONS	WORKING PRESSURE	DIAMETER DRIVERS	COMBINED TOTAL HEATING SURFACE	WEIGHT IN 1000'S ON DRIVERS	WEIGHT IN 1000'S TOTAL	RATED TRACTIVE FORCE	GRATE AREA	TENDER WEIGHT IN 1000'S	TENDER FUEL TONS-GALS	TENDER WATER GALLONS	TENDER WHEELS
1	460	L.M.S.	Pullman	18½×28	225	72	2009	121	162	25450	286	119	10	5300	6
2	280	L.M.S.		18½×28		56½	1895		142	32100	24	123	10	5300	6
3	4-8-2	Stanier	Stanier	20½×26	210	56	4114		518	69960	70	10000	11	10000	-
4	482	N.Z. Govt Rly	Pullman	18×26	200	54	1752	97	154	26520	39	65	6.6	2600	8
5	462	Lancashire	Hunslet	17×22	176	56	1266	66	109	18370	30	91	6.4	5300	8
6	462	L.Midland Scot	Stanier	23½×26	235	78½	3597	151.8	215	35200	52	151.5	10.7	9300	8
7	442	Belgian State		18.9×28.4	256	82.6	2406	100.7	196.2	-	39.8	-	8.8	7000	6
8	482	M.Z.A.		22.2×28	294	69	3440	167	254	-	-	166	-	-	
9	2-4-4	Transbaltic	Cockerill	27½×27½	227	52½	3320	222.2	323.4	58640	624	-	11	400	
10	462	Indo China		17.3×23	232	55.3		87	129	-	-	-	-	-	
11	460	Belgian (Congo)	Hunslet	16½×22	160	57	896	60	80	12160	16	62.2	-	-	

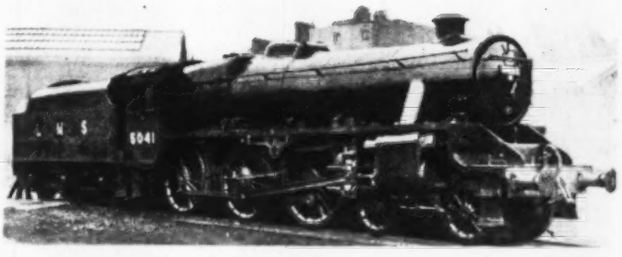


FIG. 7 4-6-0 GENERAL UTILITY LOCOMOTIVE FOR LONDON, MIDLAND, AND SCOTTISH

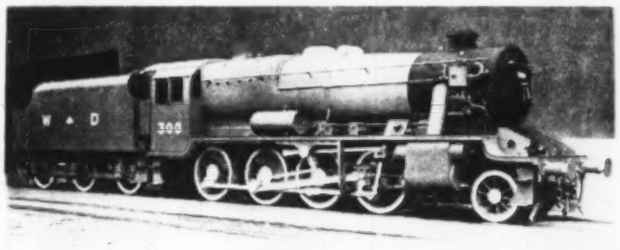


FIG. 8 2-8-0 LOCOMOTIVE FOR BRITISH WAR OFFICE

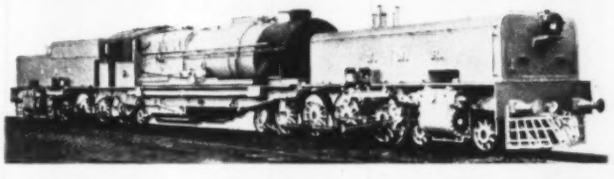


FIG. 9 4-8-2 + 2-8-4 GARRATT FOR BENGAL NAGPUR RAILWAY

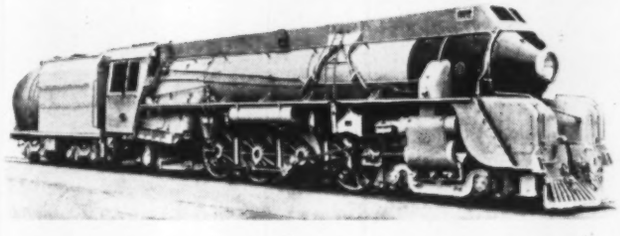


FIG. 10 4-8-2 FOR NEW ZEALAND GOVERNMENT RAILWAYS

the British War Department. The changes in the prototype engine include the use of Westinghouse air brakes in place of vacuum brakes, $1^1/_{16}$-in. mild-steel engine frames substituted for 1-in. high-tensile steel, and two live-steam injectors in place of one exhaust and one live. The engine is made available for general service by being fitted with steam heating apparatus. See Fig. 8.

No progress report of foreign locomotive construction would be complete which ignored the continuing adoption of the Garratt type articulated locomotive for heavy service in difficult situations. The Bengal-Nagpur engine, item 3, was built for a railway with 5 ft 6 in. gage and 75-lb rail sections requiring a driving-axle limitation of 37,000 lb. With this limitation 70,000 lb rated tractive force is obtained. See Fig. 9.

Item 4 is a light streamlined 4-8-2 passenger locomotive for the 3 ft 6 in. lines of the New Zealand Government Railways. The use of roller bearings on all axles on a locomotive of this size is of special interest. See Fig. 10.

The Leopoldina (Brazil) 4-6-2's, item 5, represents an adaptation of locomotives previously constructed for the burning of Brazil coal, having 11,000 Btu and ash content as high as 40 per cent. The original locomotives of this type had 17.6 sq ft of grate which is increased in the current type to 30.3 sq ft. There is a slight increase in boiler diameter and a short combustion chamber is introduced. Three sets of grates were furnished by the builders (Beyer-Peacock), an ordinary rocking grate, a table grate with small openings, and a "Waugh" firebar grate. These engines are for meter-gage track and have 10-ton axle loads.

The Lithuanian Pacifics were built by the Skoda Works, Pilsen, in December, 1939. They are of standard gage, and are designed to haul 440 tons at 80 mph on the level. They are equipped with bar frames, cast-steel tender truck frames, and Westinghouse brakes.

Item 7 represents streamlined Atlantics furnished to the Belgian State Railways for handling light trains. These engines are inside connected and are reported to have given admirable results in the light service for which they were designed. See Fig. 11.

The construction of a third line of railway across the Balkans in Bulgaria has brought attention to the 2-12-2 tank engines in use on these lines, represented by item 9 in Table 2 and Fig. 12. The locomotives were guaranteed to haul trains of 464 tons up a continuous grade of $2^1/_2$ per cent at $12^1/_2$ mph, fired with lignite with a maximum of 7600 Btu per lb. The locomotives were built by the Cegielski firm of Posen. See Fig. 12.

Item 8 is a 4-8-2 streamlined passenger locomotive built in Barcelona for the Madrid Zargossa and Alicante Railway. The locomotives develop 3000 ihp at high speeds.

Item 11, Table 2, represents an order of locomotives for the Jaipur Railway, India. This engine with weight of 80,000 lb would appear to be almost as small a "bundle" as a modern

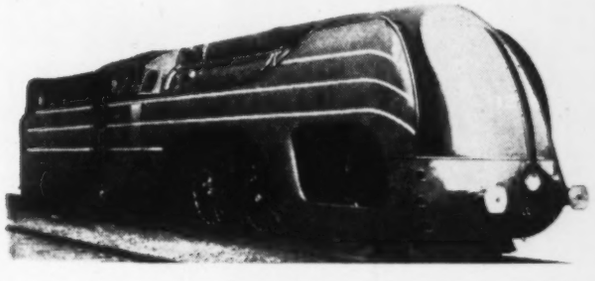


FIG. 11 STREAMLINE 4-4-2 FOR BELGIAN STATE RAILWAY

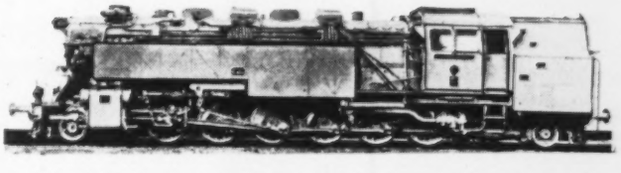


FIG. 12 2-12-2 TANK ENGINES FOR TRANS-BALKAN RAILWAY OF BULGARIA

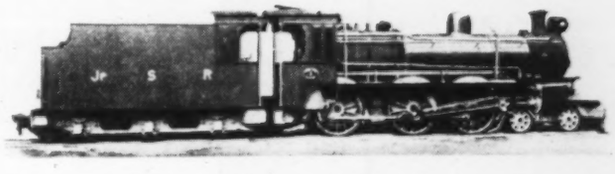


FIG. 13 4-6-0 FOR JAIPUR STATE RAILWAY

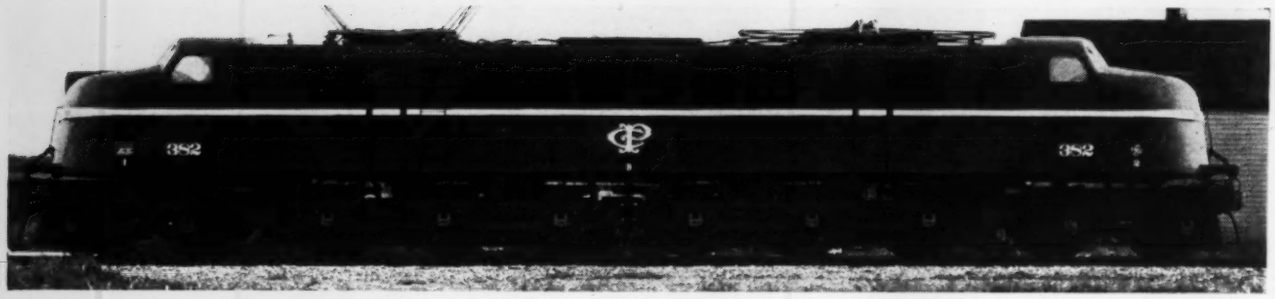


FIG. 14 2-C + C-2 DIRECT-CURRENT LOCOMOTIVE FOR PAULISTA RAILWAY

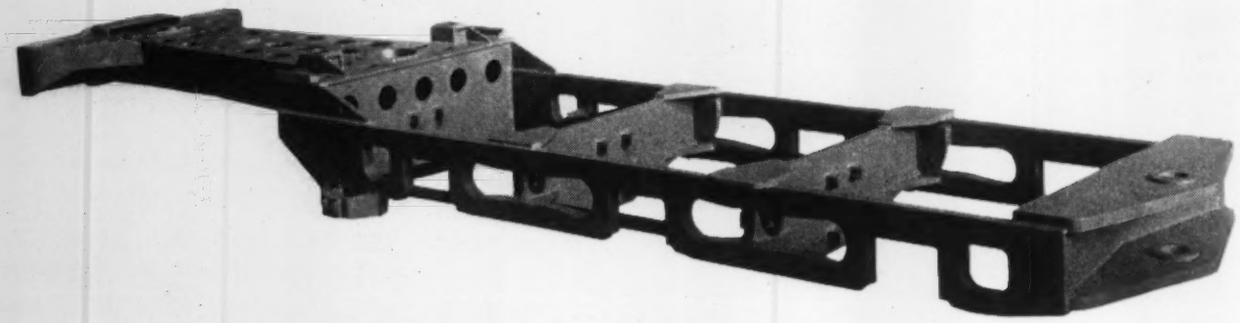


FIG. 15 WELDED TRUCK FRAME FOR PAULISTA LOCOMOTIVE

locomotive could be packed into. These were built by Hunslet Engine Company, Leeds. See Fig. 13.

4 ELECTRIC LOCOMOTIVES

Electric locomotive construction during the report year was limited to 20 units of the GG-1 class for the Pennsylvania. However, technical information relating to an order of heavy direct-current engines for South America became available just a few days too late for inclusion in last year's report.

The locomotives referred to were built by the General Electric Company for the electrified sections of the Paulista Railway, of 63-in. gage, including grades as steep as 1.85 per cent, and practically no level track, making an installation permitting regenerative braking of the greatest importance. These locomotives are of the 2C-C2 type, with hourly ratings of 4470 hp and continuous rating of 405 hp. The trolley voltage is 3000, the six 1500-volt traction motors being operated either in full series, two parallel groups of three in series, or three parallel groups of two in series. The cab underframes and the frames for the driving and guiding truck are entirely assembled by welding. The locomotive is illustrated in Fig. 14 and Fig. 15 shows one of the welded main truck frames.

5 THE GAS-TURBINE LOCOMOTIVE

The possibilities of the gas-turbine locomotive have been exhaustively investigated by the Allis-Chalmers Mfg. Co., and these have been presented in this country during the year by a bulletin prepared by this company, also by Adolphe Meyer, Engineering Director of Brown, Boveri Company, of Baden, Switzerland,[2] and by the Turbine and Condensing Locomotive Committee of the Railway Fuel and Traveling Engineers' Association.[3] Dr. Meyer reported that his company had actually under construction a locomotive of this type for the Swiss Federal Railways with a rating of 2200 hp, and satisfactory reports of the performance of stationary units have caused the Allis-Chalmers Mfg. Co. to proceed with construction of several gas turbines, which are now in service in oil-refinery plants. The company has taken a license to build the combustion turbine in this country and has energetically studied the possibilities of locomotive applications.

The prime mover consists of a combustion chamber in which preheated oil is burned with temperatures rising to 3300 to 3600 F. Air for combustion is supplied at 45 psi gage and 365 F, and the resulting gas mixture at a temperature of about 1000 F is passed through the stages of a reaction-type gas turbine and exhausted to the atmosphere or a heat exchanger at about 600 F. Mounted on the same shaft with the turbine rotor is an axial compressor which draws atmospheric air or air preheated in the exchanger and compresses this to the desired state for mixing in the combustion chamber. It is expected that a gas turbine capable of developing 10,400 hp at 4000 rpm will require about 7900 hp for the compressor drive, leaving a net output of 2500 hp. Both turbine and compressor will work at about 83 per cent efficiency, and without preheating the compressed combustion air, the efficiency of the set will be about 17 per cent. Dr. Meyer believes on the basis of experience with Diesel superchargers that the gas mixture can be delivered to the turbine at a temperature of 1200 F in place of 1000 F by the use of adequate preheater surface between the two turbines, thus raising the efficiency of the set to a figure comparable with that of the Diesel engine, say 33 per cent.

The proposed locomotive is to be driven through Voith combined hydraulic torque converters and couplings. This is a device in extensive railway service abroad which can be built in this country under license by the American Blower Company. Converter and coupling may be housed in a common housing. The converter, which changes moderate torque at high speed

[2] "The Combustion Gas Turbine," by Adolphe Meyer, MECHANICAL ENGINEERING, vol. 61, 1939, pp. 645–652.

[3] The reports of this committee are principally the work of L. P. Michael, Mem. A.S.M.E., of the Chicago and North Western Railway.

into proportionally higher torque at reduced speed, is used for starting and accelerating periods, after which the coupling is thrown in for high-speed operation. The runners or driven members of both converter and coupling are keyed directly to the driven shaft. The converter efficiency rises to a maximum of 84 per cent at 35 mph, and the coupling efficiency is practically unity at high speeds. The principle of action of the converter is that of a reversed fan motion. Oil is driven against the blading of the driven shaft and sets the latter in motion. The fluid transmission requires two sets of drives for each truck, one for motion in each direction. The drive shafts are connected by worm gearing to the driving axles in each truck.

The locomotive design proposed has an 88-ft cab structure on a girder frame carried between 1B1 power trucks at each end. The driving equipment consists of two 2500-hp gas turbines, each provided with suitable couplings for forward and backward motion. Such a locomotive will weigh 500,000 lb and provide a starting tractive force of 70,000 lb and a maximum speed of 120 mph with 52-in. drivers. Fig. 16 is a schematic diagram of the gas turbine with combustion chamber and Fig. 17 a diagram of a 5000-hp gas-turbine locomotive with two 2500-hp turbines and hydraulic transmission.

STREAMLINER COACH

A piece of coach equipment of special interest which has few if any counterparts in this country but corresponds closely to many cars abroad is the suburban streamliner coach built by the American Car & Foundry Co. for the New York, Susquehanna, and Western. These are 80-seat, double-ended, center-entrance, streamlined coaches designed for operation in single units. The power unit is a Waukesha "pancake engine" with

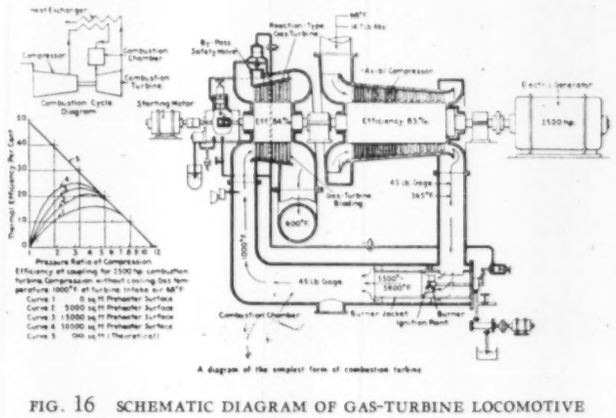


FIG. 16 SCHEMATIC DIAGRAM OF GAS-TURBINE LOCOMOTIVE

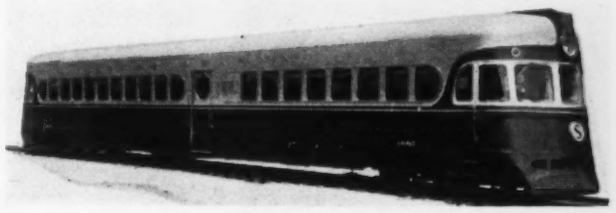


FIG. 18 DIESEL HYDRAULIC RAIL CAR FOR SUSQUEHANNA AND WESTERN

FIG. 19 VIEW FROM SMOKING COMPARTMENT OF SUSQUEHANNA AND WESTERN CAR

(Smoking compartment is upholstered in imitation leather with the mohair-upholstered section beyond the entrance doors.)

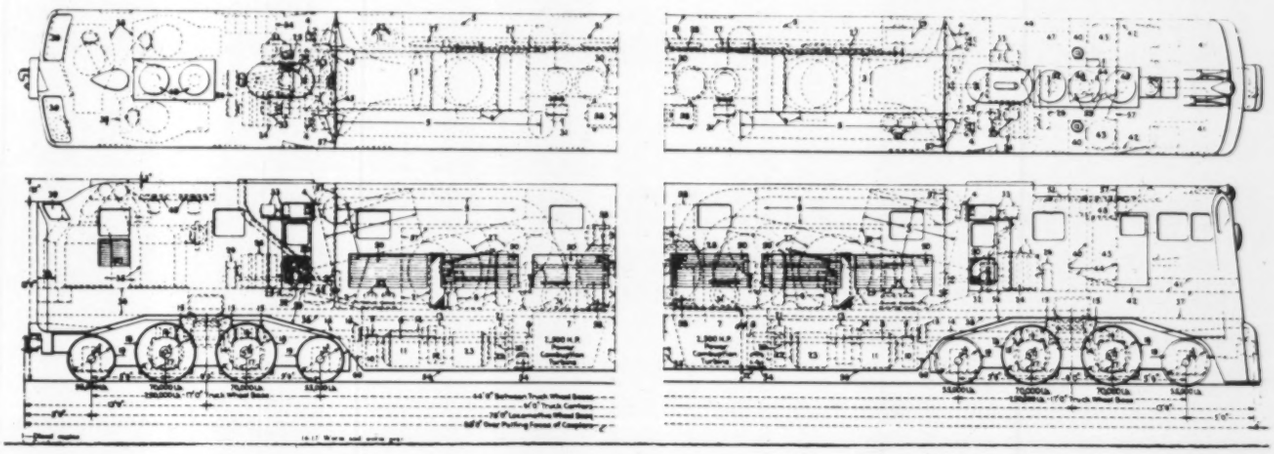


FIG. 17 ARRANGEMENT DIAGRAM OF GAS-TURBINE LOCOMOTIVE

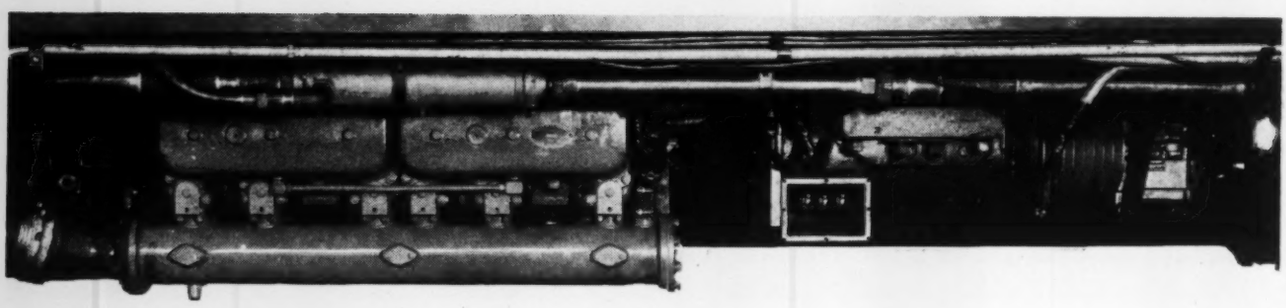


FIG. 20 ENGINE ARRANGEMENT OF SUSQUEHANNA CAR

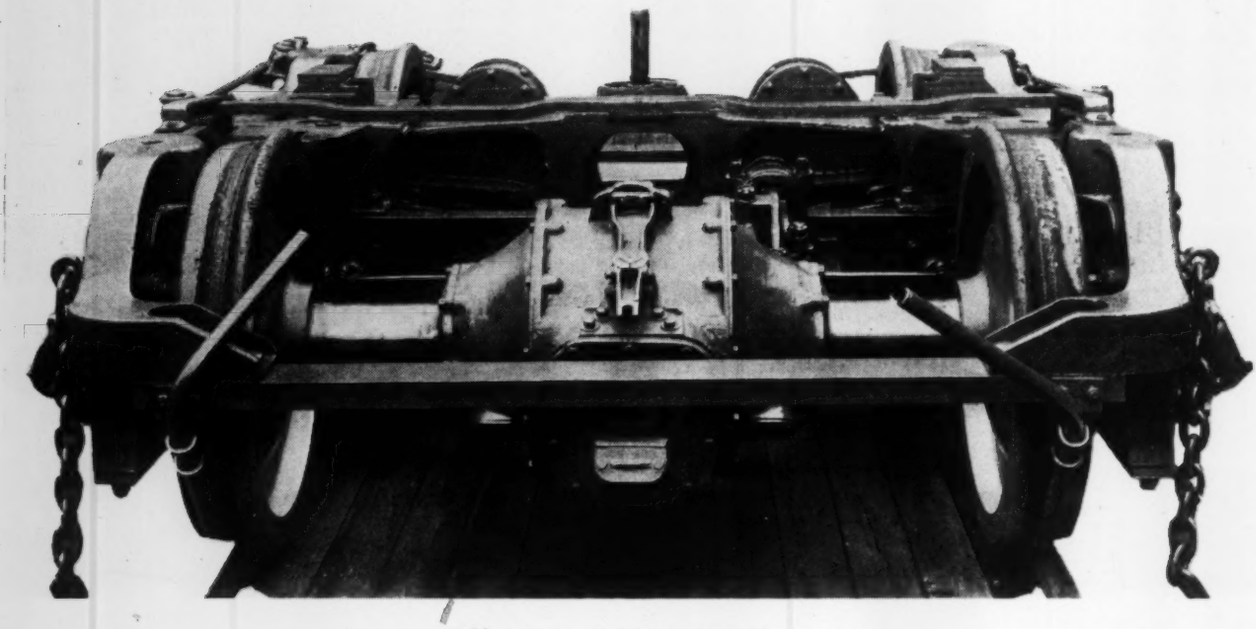


FIG. 21 POWER TRUCK OF SUSQUEHANNA CAR

six $6\frac{1}{4}$ by $6\frac{1}{2}$ in. cylinders supercharged to produce a maximum of 290 bhp at 1800 rpm. The transmission used is the Voith combination torque converter and coupling, mentioned in discussing the gas-turbine locomotive. A twin-disk hydraulic element provides multiplied torque at reduced speeds for starting and acceleration, and this is combined with a direct coupling of drive shaft to propeller shaft for operation at higher speeds. A twin-disk clutch, electropneumatically operated, is provided for the engagement of the direct drive or the converter as desired, and reverse operation is secured by shifting a jaw-clutch on the single driving axle. Fig. 18 shows the outside appearance of the car and Fig. 19 is a view from the smoking compartment, upholstered in imitation leather, back into the mohair-upholstered section beyond the entrance doors. Fig. 20 shows the pancake engine and part of the transmission and auxiliary equipment mounted under the car floor. Fig. 21 shows the power truck with the reversing-clutch housing on the driving axle. The weight of the car ready for service is 76,400 lb, of which 10,360 lb is in the truck with the driving axle. Air-conditioning is of the electromechanical type with freon as the refrigerant.

6 DIESEL-ELECTRIC LOCOMOTIVES AND TRAINS

The Diesel-electric field of the report year is specially characterized by the marketing of stock types of switchers, normally of 660 and 1000 hp, by the principal builders. These are represented by items 1 to 4 in Table 3, and by Figs. 22 and 23.

TABLE 3 DIESEL-ELECTRIC LOCOMOTIVES

Item No	Railway	Service	Builder	Horsepower Rating	Number of Power Plants, Cylinders Number, Diameter × Stroke for Each	Driver Diameter	Wheel Arrangement	Total Wt of Locomotive	Continuous Tractive Force, lb	Continuous Tractive Force, at mph	Notes
1	Stock	Switching	ALCo	660	1, 6-12½×15	40	B+B	136000	28000	6	
2	Stock	" "	ALCo	1000	1, 6-12½×15 Supercharged	40	B+B	230000	34000	8	
3	Stock	" "	BLW	660	1, 6-12¾×15½	40	B+B	200000	28000	6½	
4	Stock	" "	BLW	1000	1, 8-12¾×15½ Supercharged	40	B+B	240000	33000	8.3	
5	CR I&P	Pass.	ALCo	2000	2, 8-12½×13 Supercharged	40	A1A+A1A	345000	17300	34	"Rocket"
6	CA MW	Pass	EMC	900	4, 8-8½×10	40	(2+2)A1A+A1A	616000	32400	40	400
7	EMC	Freight	EMC	1350	4, 8-8½×10	40	(A+1)B+(B+1)	360000	109600	9.6	Demonstrator
8	Mo Pac	Pass	EMC	2000	2, 8-8½×10	40	A1A+A1A	308000	16200	40	Eagle
9	Tulsan	Gen'l	GE	500	1, 6-10½×13	35	B+B	123000	17900	5	
10	CR I&P	General	Davenport	360			B+B	58000	11800	6	

Diesel-electric passenger power is represented by the new American Locomotive *Rocket*, Fig. 24, the Missouri Pacific *Eagle*, Fig. 25, and the locomotives for the new *400* trains of the Chicago and North Western.

The Electro-Motive Corporation has placed in service a sample freight locomotive, which consists of two units, each having two 1350-hp engines. See Fig. 26.

Diesel-electric orders for 1939 included 30 units of 400 hp or less for light switching and road service, 90 switchers of 500 to 660 hp, 62 switchers of 1000-hp, one 1500 hp, and five of 2000 hp, all the latter consisting of two units driven by multiple-unit control from a single cab. There were 23 passenger units of 20,000 hp and two 4000-hp two-unit passenger locomotives.

Late in 1939 the Chicago & North Western placed in service new Diesel-electric streamliners to take the place of standard equipment in the *400* service. Each train consists of a two-unit locomotive, with four 1000-hp power plants, and ten cars. The locomotive weighs 616,000 lb in working order and is carried on four six-wheel trucks, the inside axle of each being for weight carrying purposes only. See Fig. 27. The engines are General Motors' two-cycle V-12 type. All cars have independent trucks and range in weight from 112,900 for the parlor drawing room to 125,000 for the diner. The cars are 82 ft long except the diner, which is 8 ft longer. The cars were built by the Pullman Standard Car Manufacturing Company. The train weighs 577 tons in working order and thus almost 7 hp per ton is provided. The framing for the cars is high-tensile alloy steel, of the welded girder type construction. Inside finish is of aluminum. Air-conditioning is of the mechanical type with a Waukesha engine-compressor set and accessories.

Two new designs of Diesel-electrics have been delivered to Mexican Railways. The Yucatan engines have Cooper-Bessemer 500-hp 750-rpm, four-cycle engines with six $10^1/_2 \times 13^1/_2$ in. cylinders, and four traction motors, each of 108 hp continuous rating. The engines are of the usual B+B type and weigh 140,000 lb in working order. The continuous tractive force is 17,900 lb at 8 mph. The Texas Mexican engines represent a considerable departure from the conventional B+B arrangement. They have four axles, each motor driven, mounted in a continuous bar-frame with fixed pedestals. The engines are six-cylinder De La Vergne $12^1/_2 \times 15^1/_2$ in. rated at 660 hp at 600 rpm. These locomotives haul freight trains up to 950 tons in weight, and can be operated safely on light track at speeds as high as 40 mph.

The Temiskaming and Northern Ontario has recently put into service a Diesel-powered train consisting of a power unit and two coaches. The power unit was originally a gasoline-electric coach built by Brill in 1926 and in constant service since that time. A Commins six-cylinder Diesel engine rated at 250 hp at 1000 rpm was selected as suited to operation with the existing electrical equipment and controls. The engine is started by compressed air obtained from a small gas-engine-driven compressor. Passenger seats were removed from the power units in order to provide more space for baggage and express. The power unit in working order weighs 120,000 lb. Each of the two coaches is 55 ft 6 in. long; the first-class car weighs 57,300 and has a smoking compartment; the second-class car weighs 55,400 lb; the latter seats 44 and the former 52. The total weight of the train is about 115 tons, providing a weight of 2400 lb per seat and a horsepower per ton of weight of 2.2. This train operates at a fuel rate of 2 miles per U. S. gallon of fuel.

Item 10 represents a group of small locomotives in service and under delivery to the Rock Island, built by the Davenport Besler Corporation. They have been employed both in regular switching service and general branch-line service. Operating

FIG. 22 660-HP STOCK-TYPE DIESEL-ELECTRIC LOCOMOTIVE FOR THE NEW HAVEN (A. L. CO.)

FIG. 23 1000-HP STOCK-TYPE DIESEL-ELECTRIC LOCOMOTIVE (BALDWIN LOCOMOTIVE WORKS)

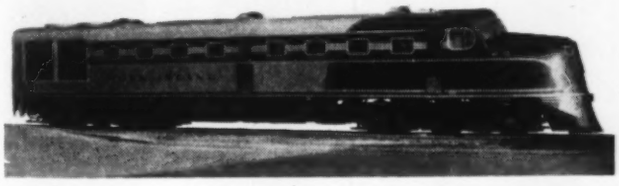


FIG. 24 "ROCKET" DIESEL ELECTRIC PASSENGER LOCOMOTIVE FOR ROCK ISLAND

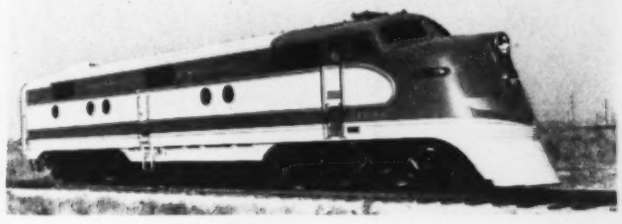


FIG. 25 DIESEL-ELECTRIC PASSENGER LOCOMOTIVE FOR MISSOURI PACIFIC "EAGLE" TRAINS

FIG. 26 E.-M. CORP. "DEMONSTRATOR" DIESEL ELECTRIC FREIGHT LOCOMOTIVE

FIG. 27 DIESEL-ELECTRIC PASSENGER LOCOMOTIVE FOR CHICAGO & NORTH WESTERN

and repair cost on these engines has been extremely favorable.

The Missouri Pacific's *Eagle* trains each consist of a 2000-hp Electro-Motive Corporation locomotive (Fig. 25) and six streamline cars built by the American Car and Foundry Company. The four passenger cars, coach deluxe, coach, diner-bar-lounge, and parlor observation, seat a total of 230 persons. The cars are built of aluminum alloys and vary in weight from 101,000 lb for the parlor observation to 113,000 for the diner. The trucks have cast-steel Commonwealth frames and A.C.F. roller bearing wheel units. The journals are 6 × 11 in. on the mail storage car, the baggage end of the mail-baggage combination, and the kitchen end of the diner. Other trucks have 5 × 9 in. journals. Both bolster and equalizer springs are of the helical-coil design of alloy steel. Vertical motion is controlled by Munroe shock absorbers. With a total weight of 457 tons including the locomotive, 4.4 hp per ton of load is provided.

FIG. 28 NIGHT ARRANGEMENT OF PULLMAN TRIPLE-DECK SLEEPER

FIG. 29 DAY ARRANGEMENT OF PULLMAN TRIPLE-DECK SLEEPER

7 PASSENGER CARS

Orders for passenger equipment during the report year consist almost entirely of lightweight cars for streamliner or other special trains. Outstanding are the new style Pullman coach sleepers. The Pullman Company put into service in June two of the new triple-deck sleepers with 45 beds in each car arranged in tiers of three. Each car has ten compartments, six with two tiers each and the remainder with one tier each. During the day passengers occupy upholstered adjustable seats with individual arm-and-foot-rests. The lower berth is formed by the seat back. The upper berth is stationary and high enough to clear the head of a tall person. The intermediate berth is raised against the upper during the day, and at night it is lowered to mid-position between upper and lower berth and forms a partition between compartments. Each berth is provided with individual curtains, clothing shelf, and hammock, and each compartment has a ladder for the convenience of the occupants of the two higher berths. See Figs. 28 and 29.

The new *Daylight* trains have three articulated chair-car units per train, with two bodies and three trucks; also a three-body-on-four-trucks unit coffee shop, kitchen, and pantry, and parlor observation car.

Among the coach orders of special interest is a group of cars with 76 individual adjustable seats installed by the Delaware and Hudson. The cars weigh 112,900 lb, of which 37,000 lb is in the two four-wheel trucks. These cars employ U.S.S. Cor-Ten and carbon-steel structural shapes in the sides and underframing. The underframe, side frames, and roof frames were completely spot welded in suitable jigs. The exteriors are smooth, but there is no further streamlining than aprons along the side of sufficient depth to cover the underfloor equipment.

TABLE 4 FREIGHT CARS

Item No.	Type	Road	Builder	Inside Dimensions	Cubic Ft.	Load Limit	Light Weight	Journ.	Trucks
1	50-ton Box	U.P.	Ry.	40-6 × 9-2 × 8-6	3180	124 800	44 200	5½ × 10	Sym.-Gould
2	50-ton Box	C&NW	M.P.Ver	50-6 × 9-2 × 10-2	4430	119,200	49800	5½ × 10	Barber Stab'zd
3	70-T. Covered Hpr	B&O	Ry.	26'3 × 9'8	1700	159 240	50760	6 × 11	
4	Refrigerator	Can.Nat.	Ry.	40-0 × 8-5 × 6-7	2216	65,300	70, 200	5½ × 10	Barber Stab'zed
5	70-Ton Hopper	N&P	ACF	29-3 × 9-5½	1958	158 400	51,600	6 × 11	Buckeye.
6	50-Ton Hopper	N.P.	ACF	33-0 × 10-4 × 10-5	2051	128000	48,000	5½ × 10	Nat'l Type B
7	50-Ton P.S. Box	D.L.W.	Mapor	40-6 × 9-2 × 10-0	3712	125 000	44 000	5½ × 10	Symington
8	50-Ton Auto-box	D&RGW.	PSCCo.	40-6 × 9-2 × 10-1	3961	125,000	44000	5½ × 10	
9	50-Ton flat	W.M.	Greenville	51-4 × 9-0	-	120-900	46700	5½ × 10	
10	50-Ton hopper	D.L.W.	ACF.	34-0 × 10-1 × —	2450	139,700	38,300	5¾ × 10	
11	40-Ton refrigerator	St.L.R.Co.	—	40-9½ × 8-2 × 7-4¾	3446	81,000	54,100	5 × 9	Nat'l Type B

Air-conditioning is electromechanical of 7 tons capacity. Exterior finish is in dark green with a gray panel and orange stripe. The wheels are 36-in. diam, ground and balanced, fitted with clasp brakes and provided with A.S.F. roller bearings.

8 FREIGHT CARS

A group of the year's most interesting designs is shown in Table 4. The all-steel refrigerators adopted by the Canadian National after several years' experimentation with top icing involve many innovations. In tests these cars have shown a considerable reduction in the usual temperature gradient between the top and the bottom of the lading. There are eight overhead ice bunkers, with a capacity of 6500 lb of crushed ice plus about a ton of salt. Continuous baffles under the ice catch the meltage and conduct it to vertical flues at the sides, whence it runs down to floor tanks which retain half of the brine.

The superstructure is of steel, wood-lined and steel-sheathed. The subfloors are of steel, and the floors immediately under the

racks are cadmium plated. The cars are equipped with underslung charcoal heaters, with manually controlled drafts. General views and details are shown in Figs. 30, 31, and 32.

Item 1, Table 4, is the new "challenger merchandise service" car of the Union Pacific, designed for high-speed operation. The trucks are of the Symington-Gould double-truss type, and ten cars of the first order are equipped with roller bearings. The cars are fully lined with douglas fir. The superstructure is riveted and similar to the A.A.R. standard car. The cars are equipped with steam heat and signal lines.

The North Western box cars are notable for their large "cubage," and for their 3270-lb reduction in weight below the A.A.R. standard with comparatively limited use of low-alloy high-tensile steels, employed in the underframe and siding only.

Item 3, Table 4, represents an order of covered hopper cars built by the Baltimore and Ohio in its own shops. These cars follow the "covered wagon" standard on this line and have Duryea cushion underframes. They have continuous side posts and carline; one-eighth side and roof sheets are continuous to centerline of top, where they are lap-jointed. With Duryea underframes, the center sills are subject to end loads and buffing shocks only and are not part of the girder structure of the car. Load limit is 159,200 lb.

Item 10, Table 4, represents an order of 500 lightweight hoppers for the Lackawanna by the American Car and Foundry Co. in which the use of Cor-Ten for the car body and Man-Ten for sills results in a light weight of 38,300 lb and a corresponding load limit 15 tons in excess of the nominal 50-ton rating.

Item 5, Table 4, represents an order for 70-ton lightweight covered hopper cars principally designed for cement handling, built for the Nickel Plate by the American Car and Foundry Co. Unloading is facilitated by the use of Syntron electric vibrators, drumming on the slope sheets at a frequency of 3600 cycles per minute. These cars have been unladed into open cement hoppers in 22 min.

Item 10, Table 4, represents an order of 50-ton automobile box cars built by the Pressed Steel Car Company for the Rio Grande. These cars have auxiliary inside doors, making a total of 15 ft door width for loading. Duryea cushion underframes are applied.

Item 11, Table 4, represents a group of lightweight refrigerator cars built and placed in service by the St. Louis Refrigerator Car Company. The novel feature of these cars is the use of plywood replacing conventional tongue-and-groove construction for floors, lining, roof, siding, and insulation. The use of plywood in this manner is responsible for a saving of more than 6000 lb in the weight of the car.

Several railways gave attention during the year to the matter of improving cabooses. Improved riding qualities, neatness of interior arrangement, and convenience of train crews were sought. There is a general movement in the direction of avoiding the structural and other disadvantages of the old-style cupola, and the substitution for this of side observation windows, these observation bays extending about a foot beyond the side of the car, and affording a good opportunity for trainmen to examine the sides of their train, especially in rounding a curve. The cars are well insulated, are generally of welded construction, and are large enough for the convenience of the working crew and a dead-head crew besides. The light weights range around 19 tons.

ACKNOWLEDGMENT

The compiler of the foregoing notes acknowledges with appreciation the assistance of the members of the Survey Committee, B. S. Cain, of the General Electric Company, K. F. Nystrom, of the Milwaukee, and John Roberts, of the Canadian National; also the American Locomotive Company, Baldwin Locomotive Works, Lima Locomotive Works, Electro-Motive Corporation, Pullman Company, American Car and Foundry Company, Allis-Chalmers Mfg. Co., *Railway Age*, *Railway Mechanical Engineer*, and the *Railway Gazette*.

FIG. 30 STEEL REFRIGERATOR CAR FOR CANADIAN NATIONAL

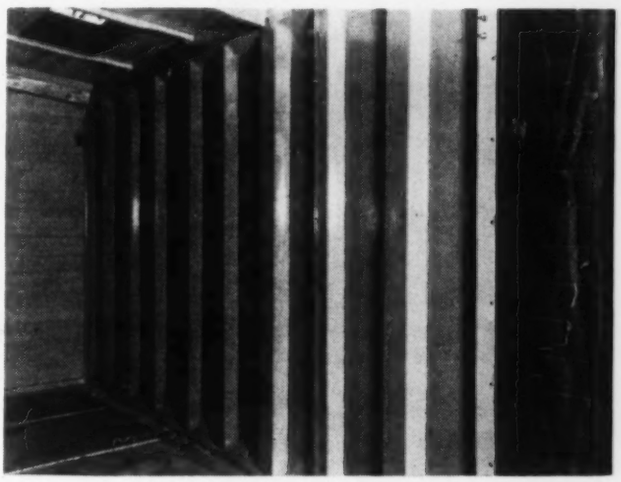


FIG. 31 INTERIOR OF CANADIAN NATIONAL REFRIGERATOR, SHOWING SIDE FLUES

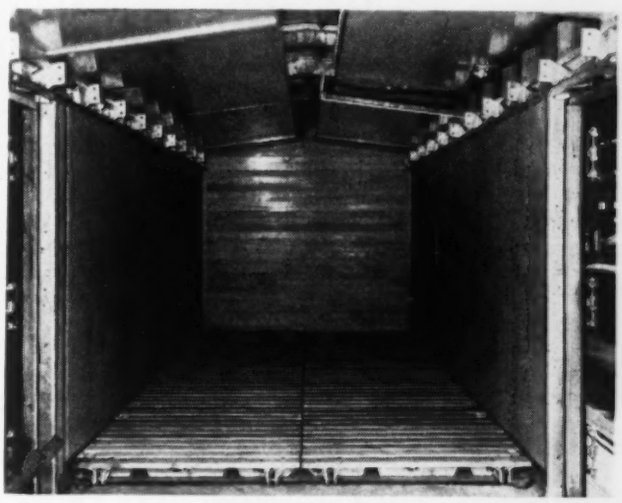


FIG. 32 INTERIOR OF CANADIAN NATIONAL REFRIGERATOR, SHOWING BRINE DRIP, TANKS, SHEATHING, AND FLOOR RACKS

FRICTION TORQUE *in* BALL *and* ROLLER BEARINGS

By HAAKON STYRI

SKF INDUSTRIES, INC., PHILADELPHIA, PA.

ANTIFRICTION bearings owe their popularity to low friction and to low consumption of lubricant. A great many factors affect the friction, but little has been published about the subject, probably because the power loss from friction in antifriction bearings is relatively unimportant. The coefficient of friction varies considerably for different operating conditions and cannot be used satisfactorily for estimating power loss in bearings. It is simpler to use the directly determined friction torque which is a relatively simple function of load and speed of the bearing but differs for different types of bearings. The amount and viscosity of the oil used for lubrication has a great effect on the torque, and the lowest torque is obtained with a very thin oil film.

TORQUE RATHER THAN COEFFICIENT OF FRICTION IS OF INTEREST

In 1900 Stribeck determined the coefficient of friction with reference to the shaft diameter for a bearing with 70 mm bore and found that the coefficient decreased with increasing loads from 0.003 at about 400 kg to a minimum of 0.0015 at 2000 to 3000 kg and that the coefficient was influenced but little by speed of rotation.

In a previous paper[1] by the author, which summarized friction tests under loads from 500 to 4600 lb at speeds of 600 to 2000 rpm, similar conclusions were arrived at. Little variation was found in the coefficient with change in speed. With change in load, however, it was found that the values were high for low loads and approached minimum for loads given in most catalogs at speeds in the range 1000–2000 rpm. The use of the coefficient of friction as a basis for estimating power loss in antifriction bearings was therefore considered arbitrary and misleading. It would be simpler to use the measured friction torque directly for this purpose, because it varied almost linearly with the load, and was practically independent of speed for small amounts of lubricant. It was even more interesting that the friction torque for the same external load did not differ much when bearings of not too greatly different sizes and of the same type were compared and provided the applied load was not much higher or much lower than what would be considered a service load. Bearings of different types would, however, have different torques for the same load.

Another objection to the use of the coefficient of friction is that various sizes and types of bearings can be used for the same shaft diameter, and there are bearings of exactly the same internal construction and, therefore, with the same frictional characteristics, that have bores of different sizes.

The power loss and the resulting heat are really what interest us, and since the power loss is directly proportional to the friction torque that is determined by direct measurements, it would seem natural to select the torque as the basis for comparing friction in bearings.

A replot of the torque curves given in the previous paper[1] for bearings which have been "run-in" is shown in Fig. 1 and some torque values calculated from data quoted in "Die Wälzlager," by W. Jürgensmeyer, 1937, are given for comparison in Table 1.

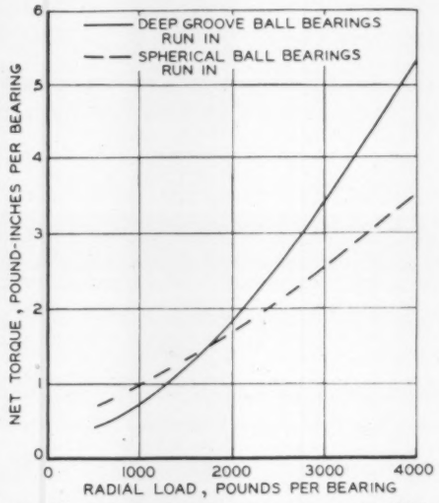


FIG. 1 REPLOT OF DATA PUBLISHED IN 1925

TABLE 1

Source	Rpm	Load, lb	Torque, lb-in.	Lubricant	Ratio groove rad to ball diam	Shaft diam, mm
Stribeck (1900)	385	2200	6.05	Oil	0.63	70
Goodman (1912)	200	1000	4.53	Oil	Small	76.2
		2000	9.65	Oil	Small	76.2
		1000	3.3	Oil	Self-align	76.2
		2000	8.2	Oil	Self-align	76.2
Forsberg (1914)	1250	1900	1.53	Grease	Self-align	45
	1250	2800	2.22	Grease	Self-align	45
Muzzoli (1934)	(?)	1000	0.95	Oil	0.53	45
		2000	1.74	Oil	0.53	45
		3000	4.2	Oil	0.53	45

TEST APPARATUS AND BEARINGS TESTED

The tests reported in 1925 were made with the dynamometer shown in Figs. 2 and 2*a*. Four bearings were mounted on the arbor an equal distance apart and radial load was applied downward on the two center bearings, through a lever system and spring scale. The four-speed driving motor was mounted in a cradle and balanced to a sensitivity 0.1 lb-in. The torque was measured by moving weights on the balancing arms until the index pointed to the origin for no torque. The lubrication used was small quantities of light lubricating oil. The coupling between motor and bearing shaft was not entirely satisfactory and the correction for losses and consequently the net torque was somewhat uncertain. In view of this uncertainty and because considerable experience in lubrication had brought new

[1] "General Properties of Ball Bearings," by Haakon Styri, MECHANICAL ENGINEERING, vol. 47, 1925, pp. 490–492.

Contributed by the Special Committee on Lubrication for presentation at the Annual Meeting, New York, N. Y., Dec. 2–6, 1940, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

problems during the intervening period, it was considered desirable to reinvestigate the friction in antifriction bearings under a few typical conditions.

In order to present the problem in a relatively simple form, only standard bearings were selected for the investigation, that is to say, bearings with standard groove radii and internal fits and with external dimensions within standard tolerances. The types of bearings used are shown in section in Fig. 3. The dynamometer used in the previous tests was also used for most of the present tests with medium-size bearings, but with a different coupling. The friction losses in a simple rubber-hose coupling were found by direct prony-brake measurements to be negligible. The four-bearing arrangement was retained because it would represent industrial mountings fairly well. The fixed-end bearings may carry some thrust because of the expansion of the shaft at higher temperatures but, as measurements indicate, can have only a small effect. Groove radii and internal fits of the bearings will, of course, influence the torque,

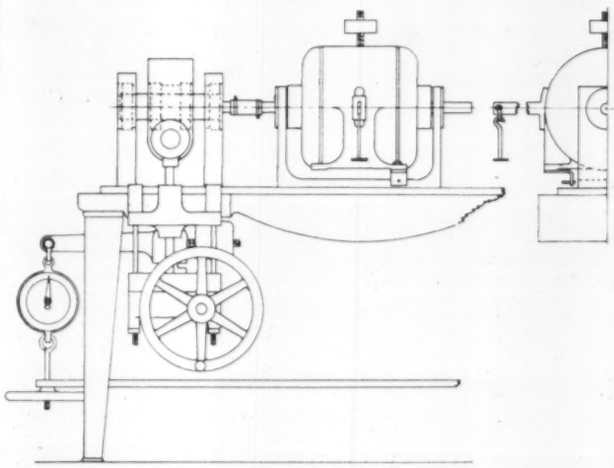


FIG. 2 DYNAMOMETER USED FOR MEASURING TORQUE OF LARGER BEARINGS

and the trend of their influence can readily be deduced from the results obtained. These factors will not be treated in the present paper.

Earlier studies of lubrication had indicated that the quantity of lubricant greatly influenced the friction, and in order, therefore, to minimize this factor, the first runs were made with as small an amount of oil added for lubrication as was considered safe for continuous operation. The quantity selected was one drop oil per bearing per hour, except for the spherical roller bearings which were given several drops per bearing about one-half hour before each test.

TESTS WITH BALL AND ROLLER BEARINGS

In Fig. 4 the torques are plotted against load for groove-type bearings (6200–6300 series), self-aligning ball bearings (1200–1300 series), and cylindrical roller bearings (NM series). In Fig. 5 the torques for the spherical roller bearings (series 21,300 and 22,300) are shown. The solid lines in the graphs indicate the load range given in the makers' catalogs for 10 per cent failure between 500 and 5000 hr at 1800 rpm. The torques at the same load for bearings within this range do not vary much in the groove-type or in the self-aligning ball series, but differ

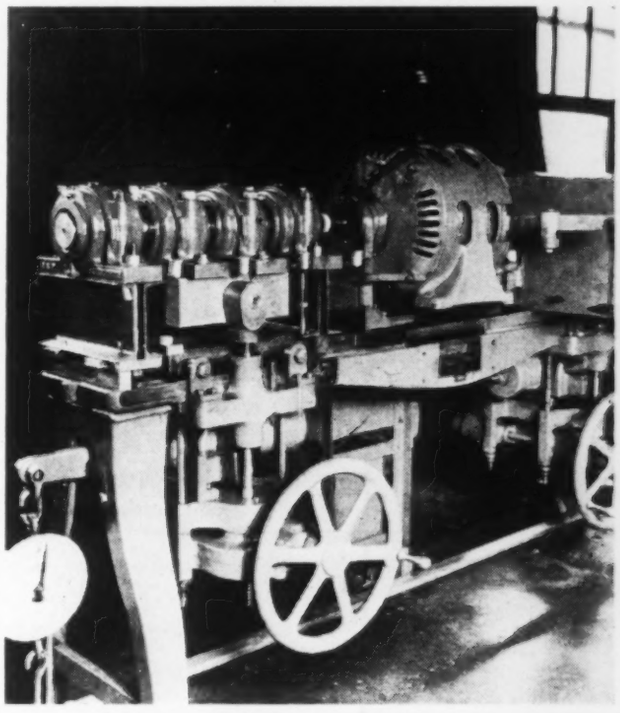


FIG. 2*a* DYNAMOMETER USED FOR MEASURING TORQUE OF LARGER BEARINGS

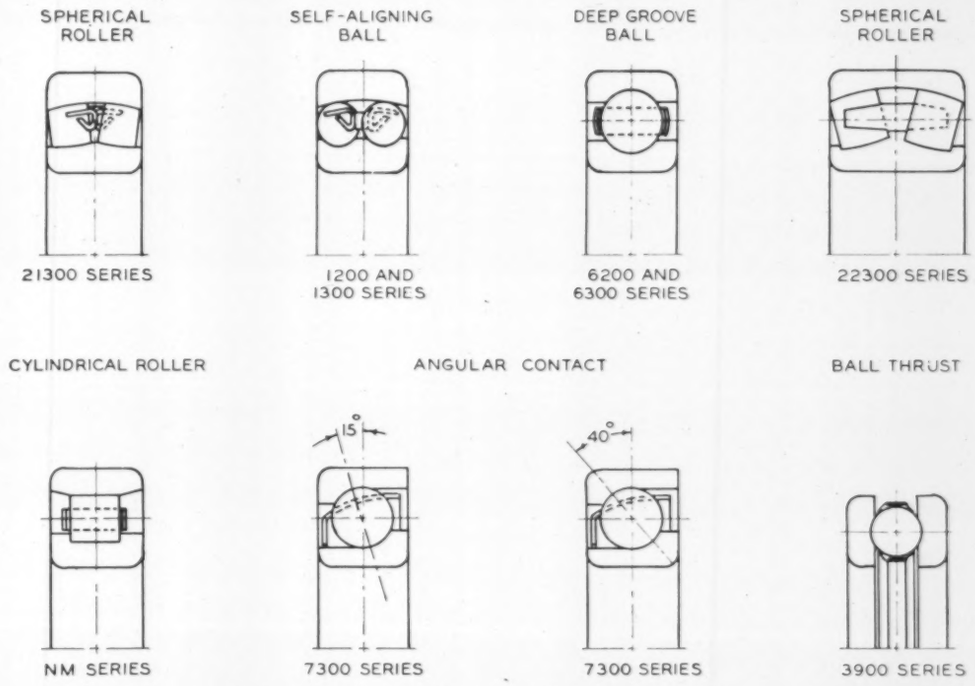


FIG. 3 TYPES OF BALL AND ROLLER BEARINGS TESTED

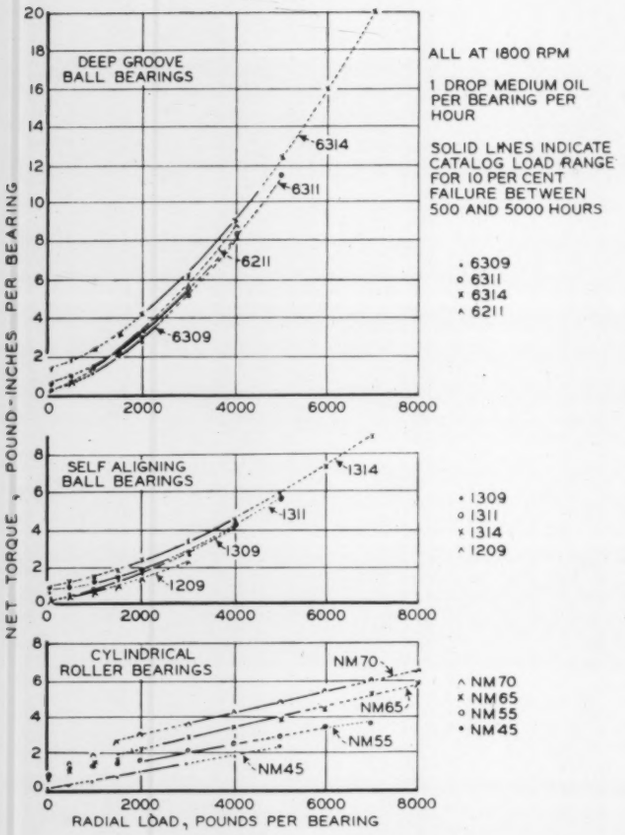


FIG. 4 TORQUE OF DEEP-GROOVE AND SPHERICAL BALL BEARINGS AND CYLINDRICAL ROLLER BEARINGS

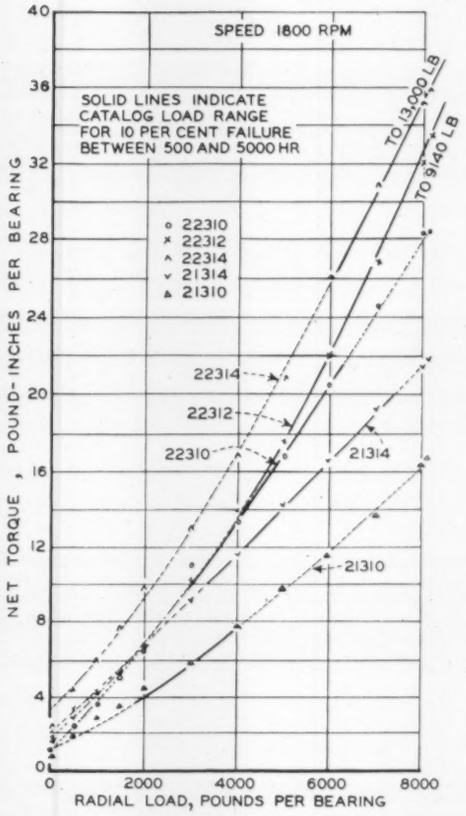


FIG. 5 TORQUE OF SPHERICAL ROLLER BEARINGS

in the roller-bearing series. Bearings in which the rolling elements are guided by pressure against flanges (21,300–22,300 series) have higher frictional torques than ball bearings for the same loads. In Fig. 6 the torques are plotted against speed for groove bearing 6314 at various loads. The pillow-block mounting used here differed from the open housings used for data in Fig. 4 and Fig. 5, but it is clearly seen that with film lubrication the torque is little influenced by change in speed.

The bearings discussed so far all represent types where the rolling elements have relatively pure rolling, except for the sliding against guide flanges under fairly light load. It was of interest to see if similar relations of torque to load and speed would hold for ball thrust bearings where there is considerable spinning of the balls. Results from tests on three different thrust bearings, namely, two of the angular contact type (size 7311) with angles of contact for the balls of 15 and 40 deg, respectively, and one of the pure thrust type (size 3914) are shown in Fig. 7. In this case the amount of lubricant was one drop per minute applied at the top of the stationary race. It is evident that the torque for the angular contact bearings under thrust is higher than for the pure thrust bearings and greater for the 15-deg than for the 40-deg contact angle, because of greater load per ball. The torque per bearing, however, does not increase proportionately to the load per ball. Again, variation in speed does not greatly influence the torque except that for the pure thrust bearing the torque at the highest speed (1800 rpm) is consistently higher than it is at the two lower speeds, which indicates the wedging influence of the ball as a result of centrifugal force, or gyroscopic forces. The torques of thrust bear-

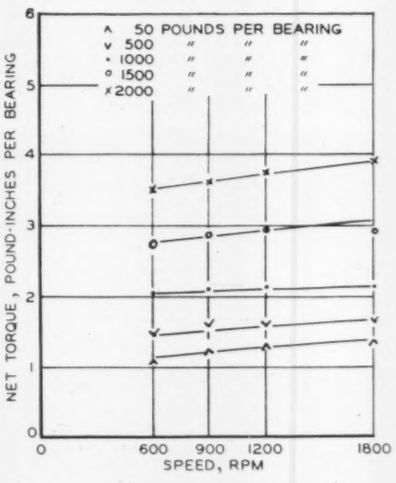


FIG. 6 TORQUE OF 6314 BEARINGS

(Approximately constant oil viscosity; pillow blocks drained overnight while running; all at 47 to 51 C; oil 185 sec Saybolt.)

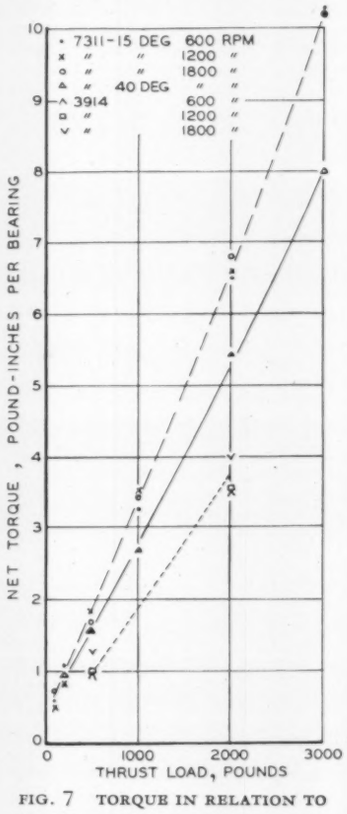


FIG. 7 TORQUE IN RELATION TO THRUST LOAD

(Lubrication, one drop per minute, medium oil.)

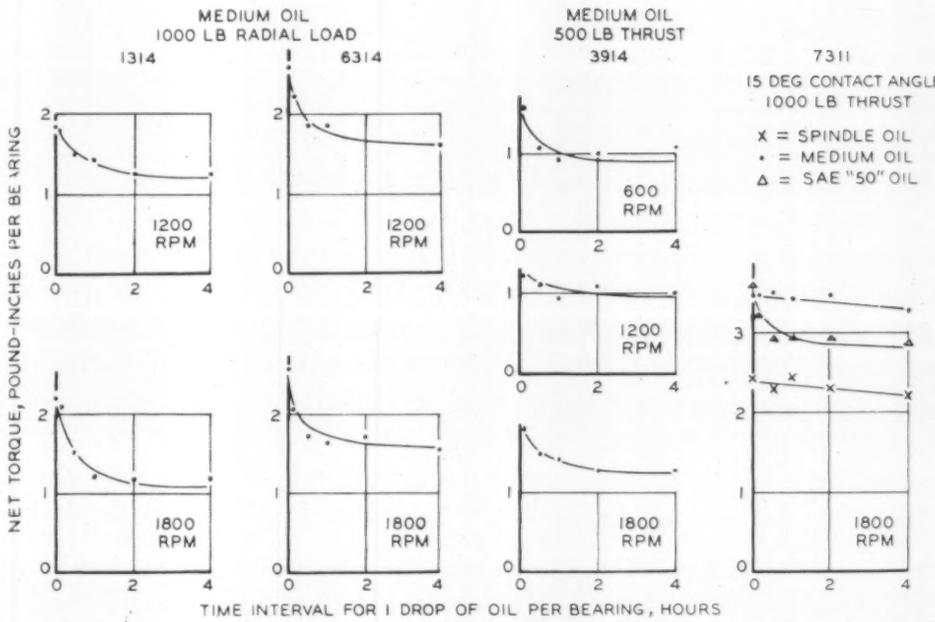


FIG. 8 TORQUE IN RELATION TO RATE OF OIL FEED

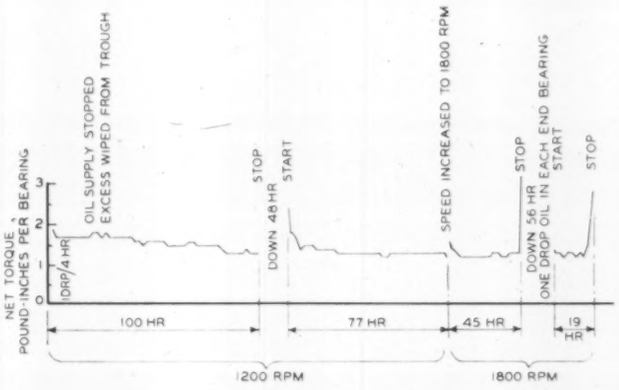


FIG. 9 TORQUE OF 6314 BEARINGS
(Run-out tests; medium oil; radial load, 1000 lb.)

ing 3914 for loads less than 500 lb could not be determined reliably on the horizontal dynamometer, as less thrust was insufficient to prevent eccentric displacement of the row of balls.

TESTS ON THE QUANTITY AND VISCOSITY OF LUBRICANTS

A more detailed study of the influence of quantity and viscosity of lubricant on friction was also of interest and for this purpose tests were run on various sizes and types of bearings.

Fig. 8 shows the change in net torque with decrease in quantity of oil down to one drop every four hours of the medium oil. The greatest change in torque is from several drops per minute to one drop per hour, after which the change for decreasing oil is smaller. For the 7311 angular-contact bearing, oils of three viscosities were used, S.A.E. 50, 750 S.S.U. at 100 F; medium oil, 284 S.S.U. at 100 F; and spindle oil, 97 S.S.U. at 100 F. It was surprising to find in this case that the torque for the heaviest oil, S.A.E. 50, was lower than that for the medium oil while the lowest torque, as expected, was obtained with spindle oil which has the lowest viscosity. This result needs further investigation with oils from the same source but of different viscosities.

A number of tests have been run with small quantities of oil and for extended time after completely shutting off the oil supply. A characteristic example is shown in Fig. 9. When the oil supply has been stopped, it is found that the torque eventually reaches a minimum and thereafter increases, first slowly and then rapidly, until possible smearing or destruction of the bearing occurs. The oil film on the ball track at the minimum point certainly must be very thin since bearings often can run up to hundreds of hours before the torque increases. The small decrease in torque from starting to running may also be noticed as a characteristic of antifriction bearings.

When oil is added in greater quantities than drop feed and partial submersion is attained, the torque increases. For the study of this effect four bearings were mounted in pillow blocks so that flood lubrication could be obtained.

Smaller deep-groove bearings (size 6205 and 6305) and self-aligning (sizes 1205 and 1305) were tested in a small dynamometer shown in Fig. 10. The torque is balanced with the torsion in a piano wire and the sensitivity is 0.01 lb-in. The results for various speeds and loads as well as quantities of lubricants are shown in Fig. 11. The torque increased approximately linearly with the load, and for small quantities of oil (film lubrication) it was found as expected that the torque does not change much with speed for the groove bearing, but somewhat more for the self-aligning bearing. However, when the amount of oil is increased the torque increases much more rapidly with the speed, and more so with a greater amount of oil. The curves represent the values for an oil level up to the center of lowest ball when the bearing is stationary. In order that change in viscosity owing to operating conditions should

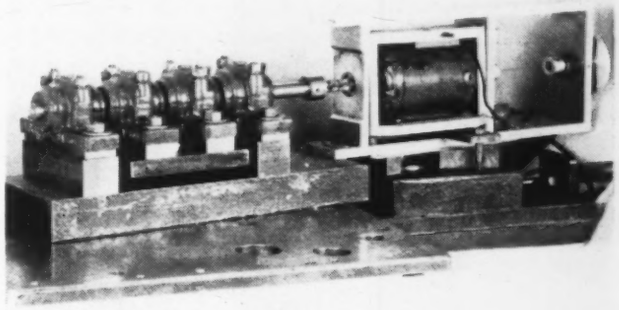


FIG. 10 DYNAMOMETER USED FOR MEASURING TORQUE IN SMALL BEARINGS

not influence the readings materially, the bearings were first run up to the highest speed and load and held for some time to obtain approximate equilibrium of temperature and, thereafter, the speed was dropped to desired values only for a length of time sufficient to measure the torque. Spindle oil was used in most of these tests, but additional runs on 1305 and 6305 were made with medium oil.

Larger bearings were tested in pillow blocks with the large dynamometer, Fig. 2*a*. Results are given in Fig. 12. It was difficult to keep uniform temperature for each series of test and the temperatures of the four bearings also differed because of the different positions and cooling characteristics of the four pillow blocks. This affects the accuracy of the values obtained, but the trend is evident. Another type of mounting would give different values. Figs. 6, 7, 11, and 12 show clearly that an increase in speed has little effect on the torque when the lubrication is light, but that the increase in torque is considerable with increase in speed when the oil level is up to the center of the lowest ball. The torque also increases with increase in viscosity of the oil, but increase in torque with increase in load is practically independent of the quantity of oil.

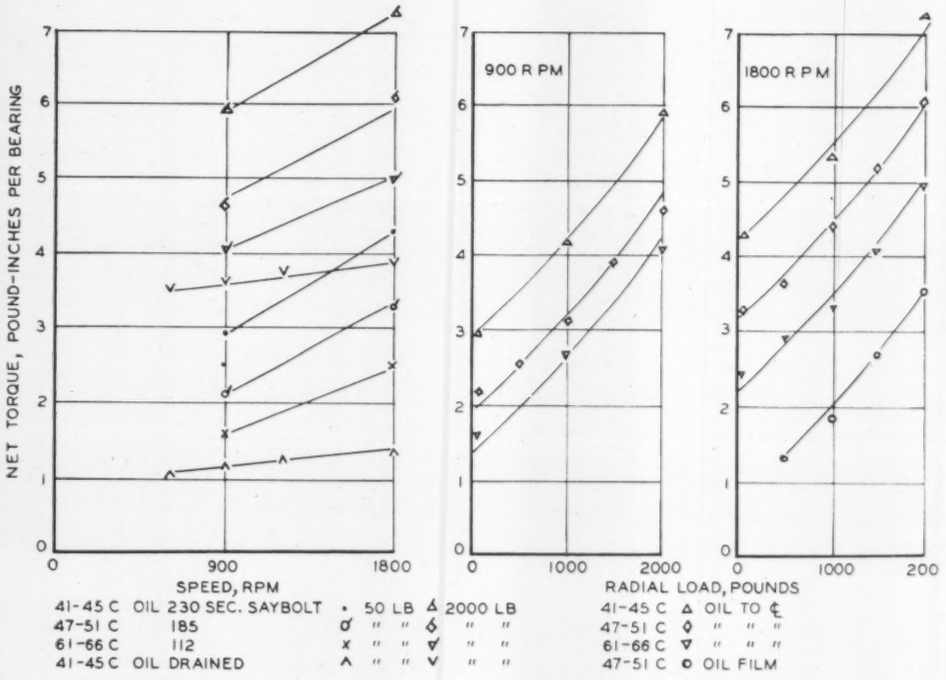

NET TORQUE, POUND-INCHES PER BEARING
SPEED, RPM
900 R P M
1800 R P M
RADIAL LOAD, POUNDS
41-45 C OIL 230 SEC. SAYBOLT
47-51 C 185
61-66 C 112
41-45 C OIL DRAINED
• 50 LB
Δ 2000 LB
41-45 C Δ OIL TO ℄
47-51 C ◇ " " "
61-66 C ▽ " " "
47-51 C ○ OIL FILM

FIG. 12 TORQUE OF 6314 BEARINGS IN RELATION TO OIL VISCOSITY
(Oil level to center of lowest ball.)

CONCLUSIONS

It has been the purpose of the present paper to discuss the principal factors that affect the friction, namely, load, speed, quantity and viscosity of oil, and type of bearing, and to avoid discussion of other important factors such as fit of bearings, internal construction, surface finish of grooves, and lubrication with greases. The tests lead to the following conclusions:

1 Friction torque is measured directly, has a relatively simple relation to speed and load, and has a greater practical value than the coefficient of friction because it can be used directly to calculate the power loss.

2 For light lubrication, torque increases almost linearly with absolute load for most bearings, but differs for bearings of different type. For roller bearings (cylindrical as well as spherical), the rate is practically linear. For ball bearings, the torque increases at a little faster rate than linear, and at a greater rate for groove bearings than for self-aligning bearings. Smaller bearings have lower friction torque than larger bearings of the same type and for the same applied load, but the difference is not great for small differences in bearing size.

3 For light lubrication, torque is practically independent of speed of rotation, provided the bearing temperature is held constant and provided the speeds are not very high.

4 For flood lubrication, torque increases with the speed of rotation and with the viscosity of the oil.

5 The power loss resulting from churning of the oil may be higher than the power loss resulting from friction of the bearing alone, depending on size and type of bearing, construction of housing, oil used, and operating conditions.

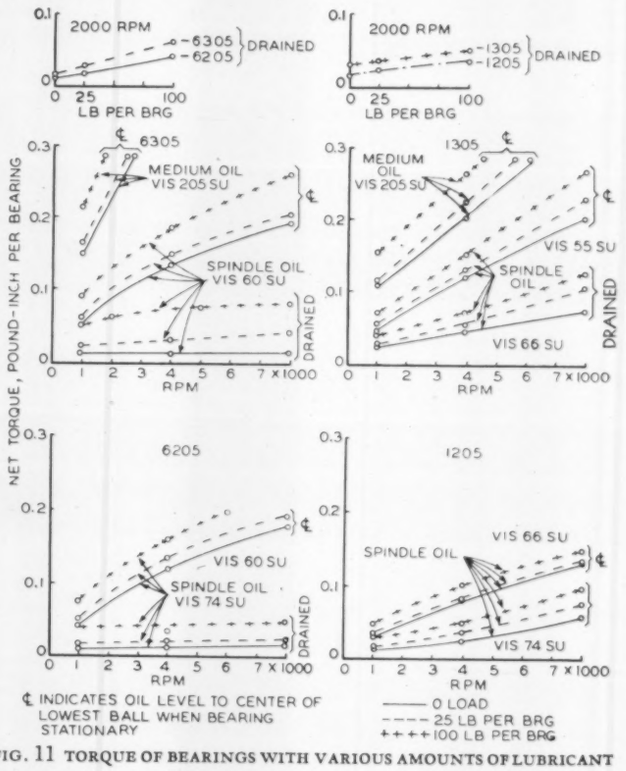


FIG. 11 TORQUE OF BEARINGS WITH VARIOUS AMOUNTS OF LUBRICANT

6 The torque is minimum for a very thin oil film. This quantity of oil is critical and will, if it is decreased, lead to seizing of the bearing and rapid increase in torque, and possibly to destruction of the bearing.

The author wishes to express his appreciation for the interested attention of Frank W. Titus and his assistants in the laboratory in making the numerous measurements and collecting the data for this paper.

A Program for
INDUSTRIAL LUBRICATION

Current Practices and Problems

By VIRGIL M. PALMER and CHARLES L. POPE

EASTMAN KODAK COMPANY, ROCHESTER, N. Y.

FEW industrial plants have the variety of lubrication requirements found in the machinery and processing equipment in the Eastman Kodak Company's plants. Extremes of operating conditions exist, such as bearings operated at temperatures from —40 F to more than 400 F, at extremely high and low speeds and exposed to chemical fumes, abrasive dusts, water, and solvents. Many other such factors complicate the lubrication problem.

Within our organization are many separate industries. In addition to the large variety of special equipment peculiar to the industry, there are steam and electric generating plants, materials-handling equipment, waterworks, paper mills, a chemical plant, metal-fabricating equipment, machine shops, and one of the largest refrigeration plants in the world.

In the paper[1] presented by the author and Horace F. Smith in 1935, an outline of a lubrication organization and some of the lubrication practices which produced beneficial results were discussed. Briefly, this program provided for standardization of lubricants through analysis of the lubrication requirements of the plant. Specifications were developed and issued through the material standards department to the plant personnel and vendors of lubricants. This enables the purchasing department to reduce the number and control the uniformity of lubricants purchased. The reduction in numbers of lubricants materially simplified the receiving, stocking, dispensing, and applying of lubricants. Standard laboratory tests were established to insure that the physical characteristics of lubricants submitted for approval and lubricants received on specifications complied with the established standards. Lubricants meeting the specifications were approved only after extensive test under service conditions. The reduction in the number of lubricants used afforded the opportunity to schedule their application as to frequency and method.

After five more years of experience, the lubrication program remains substantially unchanged. Additional activities have been added, practices have been modified, and emphasis on and importance of different elements have changed.

It is the purpose of this paper to supplement the paper presented in 1935 by discussing additional controls and some of the evident and hidden factors affecting the choice and performance of lubricants. Some of the changes in lubricants brought about by changes in refining methods to meet changed requirements in certain types of mechanical equipment since 1935 will also be discussed. Briefly this paper will cover:

1 The applications of additional controls to provide adequate provisions for the lubrication of equipment purchased, as well as special equipment built to our designs.

2 A discussion of the controls developed since 1935 to insure application of the right lubricant, in the right place, in the right quantity, at the right time.

3 Controls developed to assist preventive maintenance.

4 A discussion of factors affecting lubrication, including temperatures, materials, moisture, and choice of lubricants.

5 A discussion of the changes in lubricants which have affected the program since 1935.

PROVISIONS FOR LUBRICATION OF PURCHASED EQUIPMENT

It is fundamental that a successful lubrication program must furnish satisfactory lubricants correctly applied and reduce machine down time for lubricating, cleaning, and adjustment. In addition to the usual requirements for the lubrication of equipment, we must provide means to prevent the contamination of extremely sensitive and costly product. We must also avoid the loss of product from defects caused by the slightest wear of moving parts. This is rendered more difficult by the fact that much of the equipment is operated and maintained in almost total darkness.

In order to insure proper provisions for lubrication of equipment to be purchased or designed, a specification covering the requirements to be met has been adopted. Some of these requirements are that means shall be provided for controlling leakage of the lubricant, that it shall be possible to lubricate the machine while it is in motion, and that there shall be adequate filling and draining facilities. Experience has proved that it is expensive and annoying to change the method of lubrication after the machine is completed. This expense includes that of spoiled products and machine down time, as well as cost of changing over lubrication facilities. The purpose of our specification is initially to secure adequate lubrication means to meet requirements. Through the purchasing department, specifications for the lubrication of equipment accompany all purchase orders for mechanical equipment. Any exception to these specifications is agreed upon by the purchasing engineer, lubrication engineer, and the vendor before the order is placed. Machinery and equipment purchased under these specifications are inspected and passed by the engineering department before they are placed in service.

PROVISIONS FOR LUBRICATION OF DESIGNED EQUIPMENT

The lubricant to be used and the means of application are now specified on the drawings of our own designs. This calls for lubrication instructions suitable to the equipment and its application. With this routine, lubrication consciousness is developed by the designer to such a degree that lack of adequate information and unusual conditions or requirements result in a prompt request for assistance from the lubrication

[1] "A Lubrication Program," by Virgil M. Palmer and Horace F. Smith, MECHANICAL ENGINEERING, vol. 57, no. 9, September, 1935, pp. 565–570.

Contributed by the Committee on Lubrication of the Machine Shop Practice Division, for presentation at the Annual Meeting, New York, N. Y., Dec. 2–6, 1940, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

engineer. Attention to the lubrication requirements during the design period results in fewer lubrication and mechanical difficulties after the machine is placed in service. If the lubricating equipment is complicated, the drawings state under whose supervision the equipment should be installed.

STANDARDIZATION OF LUBRICATING DEVICES

Through scheduling lubrication, covered in the paper of 1935, there was brought to our attention the need for controlling the variety of sizes and types of lubricating devices by standardization. For our purposes certain devices have advantages, such as uniformity of feed, structural strength, ease of installation and maintenance, and, most important, reliability. Therefore, a standard list of lubricating devices which are recommended and stocked is supplied to all engineers, draftsmen, maintenance men, and purchasing agents through the materials standards department. It indicates for what purposes the devices should be selected. As a result the number of devices has been reduced, enabling us to stock immediate requirements economically. Accidents have occurred in which devices incorporating glass in the construction have been broken. This hazard has been eliminated by specifying all-metal or transparent plastic devices. The biggest advantage in standardization is that the plant personnel soon learns where to apply and how to maintain each type of device.

CONTROL OF APPLICATION OF LUBRICANTS

The lubrication surveys referred to in the 1935 paper have been continued and extended. We have found that in specifying the quantity and frequency of lubrication minimum feeds should be used only where adequate controls are available, as there is no factor of safety when running on the minimum quantity of lubricant. On the other hand lubricants should not be wasted through fear of bearing failure or through the old but false notion that if enough is sufficient more will be beneficial. No difficulties will be encountered if the lubrication requirements are fully analyzed and followed. It will be found that such controls prevent contamination of product from overlubrication, failure of bearings from underlubrication, and waste of lubricants. Experience with the performance of lubricants has proved that service can be scheduled as to the amount of lubricant and frequency as shown by the following example: Many reciprocating steam pumps of various sizes were scattered throughout the plant and there was a lack of uniformity of oil feeds for pumps of the same size when individual oilers determined the quantity of oil required. The pumps operate on 70-lb saturated steam. Fig. 1 was prepared and put in the hands of each maintenance man so that the proper supply of oil could be furnished any pump, from a 4 × 4-in. to an 18 × 18-in. size. The basis of the chart is 1,500,000 sq ft of area rubbed by the piston per gallon of oil. Experience has shown that small-size pumps require relatively slightly more oil. It is believed that this is caused by the relatively large ratio of valve and piston-rod areas to area rubbed by piston. Use of this chart resulted in cleaner return lines to the boilers and lessened the amount of oil to be removed from the return feedwater. This same procedure is applied to steam, air, and refrigeration cylinder lubrication with modifications.

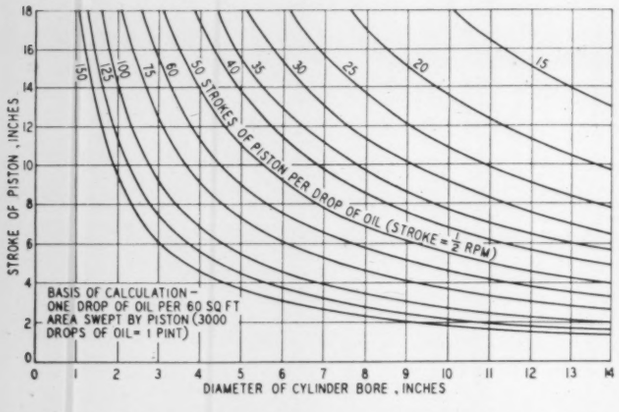


FIG. 1 CHART FOR DETERMINING STEAM CYLINDER OIL FEEDS—70-LB SATURATED STEAM

Suitable oil-level indicators are used on all gear cases and oil-lubricated ball- and roller-bearing housings. This prevents too high an oil level with consequent churning and aeration of the oil which results in higher temperatures and excessive leakage and increases the rate of breakdown of the oil due to oxidation.

Overloading bearings with grease results in excessive leakage, contamination of product, and waste of time and lubricants. Good practice for grease-lubricated antifriction bearings indicates that a bearing housing should be about one third full of grease. This is a practice which is right in principle but difficult to follow in the field. One difficulty is that manufacturers do not state whether the bearings have been serviced with grease or have merely been slushed. Another difficulty is that the grease capacity of a bearing housing is unknown to the men charged with lubricating the equipment. We have therefore adopted the following procedure in lubricating ball bearings with grease.

With the machine running, the bearing drain plug is removed and grease is forced slowly into the bearing until fresh grease starts to flow from the drain. The equipment is then run for five minutes before the drain plug is replaced. This procedure has given satisfaction in the field and is a practical method of preventing overgreasing.

It is common practice to flood plain bearings with lubricant when they overheat. This practice is often carried over to ball and roller bearings by mechanics, with consequent overlubrication which results in still higher temperatures. In starting up new equipment, we have noted bearing temperatures as high as 235 F drop back to within a few degrees of room temperature when the drain plug was removed and the excess grease permitted to run out.

If ball bearings are kept clean, they require little lubrication. We have lubricated about 4000 ball bearings without seals, 2 in. outside diameter, turning at 200 rpm, and operating at a temperature of 140 F, with $1^1/_2$ cc of grease per bearing applied at three-year intervals. This practice has been successful in preventing migration of lubricant from the bearing. The bearings are cleaned and then relubricated by means of a hypodermic needle in an air-conditioned room.

CONTROLS DEVELOPED FOR AIDING PREVENTIVE MAINTENANCE

Bearing failures are accompanied by an increase in the running temperature or by a change in the character of the sound. Experience has shown, however, that when there is a change in sound of ball or roller bearings, failure is imminent. The surfaces of the balls and races increase in roughness as bearing failure progresses, causing vibration of a different nature.

To detect incipient failures, we now use a sound recorder periodically on all critical equipment. This apparatus detects the slightest vibration in equipment which permits us to anticipate ultimate bearing failure, so that the bearing can be replaced on a scheduled shutdown of the equipment. The apparatus is illustrated in Fig. 2. It consists essentially of a crystal microphone which is placed on the bearing or some stationary part of the machine. The sound waves are picked up, amplified, and recorded on a chart (not shown) moving at a

fixed speed. By measuring the distance between selected oscillations of the needle, we can translate the vibrations into terms of rotational speed. The microphone is then taken to the bearing or bearings running at that speed and the bearing at fault located from change in the amplitude of the vibration. Although this method of inspection of mechanical equipment is not entirely new, we believe that its possibilities as an aid to preventive maintenance have not been fully utilized.

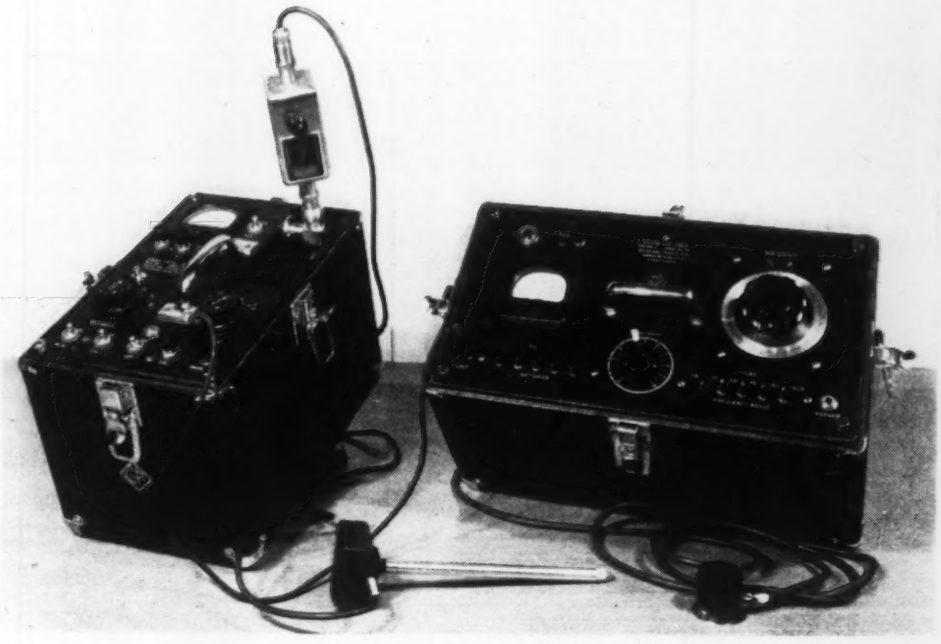


FIG. 2 SOUND-RECORDING APPARATUS FOR DETECTING CHANGES IN THE MECHANICAL CONDITION OF EQUIPMENT

FACTORS AFFECTING LUBRICANTS

In the 1935 paper were noted factors governing the choice and application of lubricants to equipment, such as character of bearings, provisions for lubrication and for retaining lubricant, and surrounding conditions. In the last five years there have been many changes in the requirements to be met by lubricants which have influenced their selection and use.

Higher power output coupled with smaller over-all size and less radiating surface has increased operating temperatures. This has caused higher oil temperatures. The effect of temperature on a lubricant is generally underestimated. In estimating the oxidation rate of a lubricant we anticipate that the life of the lubricant will be cut in half for every 15 F rise in temperature, all other conditions being equal. The figure was adopted as a result of experience and correlates well with van't Hoff's rule for influence of temperature on velocity of reactions. The greatly shortened life resulting from temperature increase does not become a factor of major importance until temperatures above 140 F are maintained.

In practice when applying oils to circulating systems a wide choice of lubricants exists from which a long service life can be expected when oil temperatures are below 140 F. Between 140 F and 200 F the choice of lubricants is more critical, and experience has shown that yearly clean up of the lubrication systems is necessary on such equipment as drum driers and steam turbines. Above 200 F the choice of lubricants becomes even more critical and definite steps must be taken to prevent shutdown caused by lubrication failures. The aforementioned relationship between temperature and oxidation is fundamental with petroleum products. Oil coolers, filters, and frequent oil changes will prove helpful in preventing oil failures.

The oil or bearing temperature does not always indicate the highest temperature to which the oil is subjected. Localized hot spots in bearings or circulating systems are easily overlooked although they are responsible for accelerating the rate of breakdown of a lubricant. As an example we have roller bearings rotating at less than 10 rpm, bath lubricated with a turbine oil having a viscosity of 120 SSU at 210 F. Bearing and room temperatures are between 95 and 100 F. The oil acquired a burnt odor after only four weeks of operation. Analysis of this lubricant, Table 1, shows by the increase in viscosity from 120 to 146 and neutralization number or acidity from 0.05 to 2.35, that the oil had oxidized to a marked extent.

TABLE 1

	New oil	Used oil
Flash, F	480	485
Fire, F	530	535
Saybolt viscosity at 210 F	120	146
Neutralization number	0.05	2.35
Precipitation number	0.00	0.1

The breakdown was apparently due to sustained high pressure and localized high temperature between bearing rollers and races in the load area. This same oil will operate over 4000 hr in ring-oiled bearings of steam turbines at 175 F.

High-temperature operation does not always indicate the need for high-viscosity oils. If the temperature is induced, there is some justification for their use. However, in equipment such as hydraulic presses, variable-speed drives, and circulating systems the temperature is caused by fluid friction which increases with viscosity. As a given unit can only radiate or conduct a given number of heat units per hour per degree temperature gradient, the high-viscosity oil increases the operating oil temperature until a heat balance is reached. No practical increase in load-carrying ability is obtained by using the heavier oil as the final operating viscosity is approximately the same, irrespective of the initial viscosity. Manufacturers of equipment often inadvertently contribute to unsatisfactory operation of their machinery by recommending heavier-bodied oils for their equipment when it is to be operated at high temperatures. As an example, the oil in a hydraulic drive was changed from the oil recommended, having a viscosity of 300 SSU at 100 F to an oil with a viscosity of 150 SSU at 100 F, with a consequent reduction in operating oil temperature from 207 F to 165 F. From the A.S.T.M. viscosity-temperature chart it will be found that the oils had approximately the same operating viscosity and consequently they afforded the same protection to the equipment. It is far better to operate at the lower temperature in order to increase the life of the oil. In this particular case oil coolers were recommended as neither oil had sufficient viscosity at the operating temperature to provide an adequate film of oil to the working surfaces.

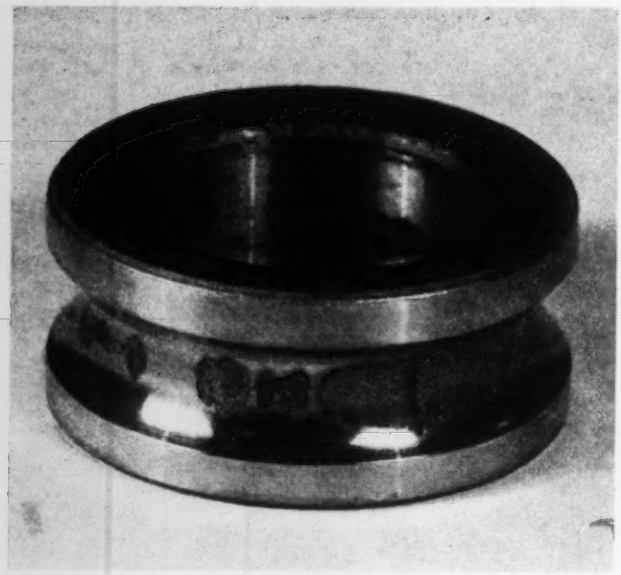


FIG. 3 INNER BALL-BEARING RACE DAMAGED BY CORROSION

Another important factor influencing the performance and therefore the selection of the lubricant is the construction material coming in contact with the lubricant. Until recently lubricants came in contact with copper, iron, steel, aluminum, and bronze only. Today, we also have synthetic plastics, monel metal, stainless steel, lead copper, cadmium silver, and many other alloys and metals.

In service, all petroleum products oxidize and form organic acids. Obviously, these acids attack some metals more readily than others. They destroy the bearing surfaces and form metallic soaps which contaminate the lubricant. Some of the metals and metallic soaps act as catalysts and greatly accelerate the oxidation of the lubricant. Metals of different potential promote galvanic action. The lubricants which contain some organic acid and then pick up moisture become good electrolytes so that galvanic action can take place. Consequently, in lubricating equipment containing dissimilar metals, care must be taken to prevent excessive oxidation of the oil and the addition of moisture.

Materials of construction sometimes contaminate the lubricant, thereby affecting its performance. It is therefore imperative that a careful analysis be made of a failure before arriving at conclusions as to the cause. An example of bearing corrosion from contamination of the oil by gasket material is shown in Fig. 3. This shows a ball-bearing race which was removed from a gear case before complete breakdown occurred. The condition of the race coupled with the pits in the balls as shown in Fig. 4 indicated that this failure was caused by corrosion. It was noticed that a large area of the gasket in the gear case was exposed to the wash of the oil. This was the only clue as to the cause of the corrosion. A piece of the gasket material one centimeter square was placed in a beaker of the gear oil containing 1 per cent water together with a tapered roller bearing and heated to 170 F for 24 hr. The oil and water mixture absorbed chemicals from the gasket forming a solution corrosive to steel, the effect of which is shown in Fig. 5. This investigation indicated the necessity of specifying gasket material for use in machine construction. This trouble may not be experienced if the gaskets are fitted properly.

The appearance of the pitted ball bearings in Fig. 4 should be compared with the appearance of the spalled balls in Fig. 6. The former is a case of chemical or corrosion failure and the latter is the result of mechanical conditions. When ball bearings run to total destruction, it is difficult to differentiate in many cases between chemical action and mechanical action. The sound-recording apparatus previously described facilitated this investigation.

The effect of moisture on the performance of lubricants has increased in importance because some of the newer lubricants fail to protect the bearings against rusting and corrosion in the presence of moisture. This condition is aggravated by the extensive use of precision bearings and the wider variety of metals used as previously discussed. All enclosed oil or grease housings must be ventilated to permit the housing to breathe so as not to develop a pressure differential. This prevents leakage of the lubricant caused by pressure equalization through the bearing seals.

When equipment is shut down or cold drafts of air strike the bearing housing, condensation of moisture within the housing generally takes place. Sodium soap grease will pick up the condensate and form an emulsion which protects iron and steel from rusting. If an oil with a high demulsibility is used, rusting or corrosion will occur unless the oil has been inhibited against corrosion. There are two other methods of meeting this situation. One is to use a compounded oil such as is used in marine service, although the compounding usually increases the oxidation rate of the lubricant. The other is to use an oil having a relatively low demulsibility which will emulsify with water. The emulsion will not cause trouble unless there are restricted oil passages in the equipment.

FACTORS AFFECTING ANTIFRICTION-BEARING LUBRICATION

As a result of the increased use of ball and roller bearings, it has become necessary to stress the factors influencing their performance. The physical characteristics of oils, such as viscosity and flash and fire points, are relatively unimportant in the lubrication of a roller or ball bearing compared with the

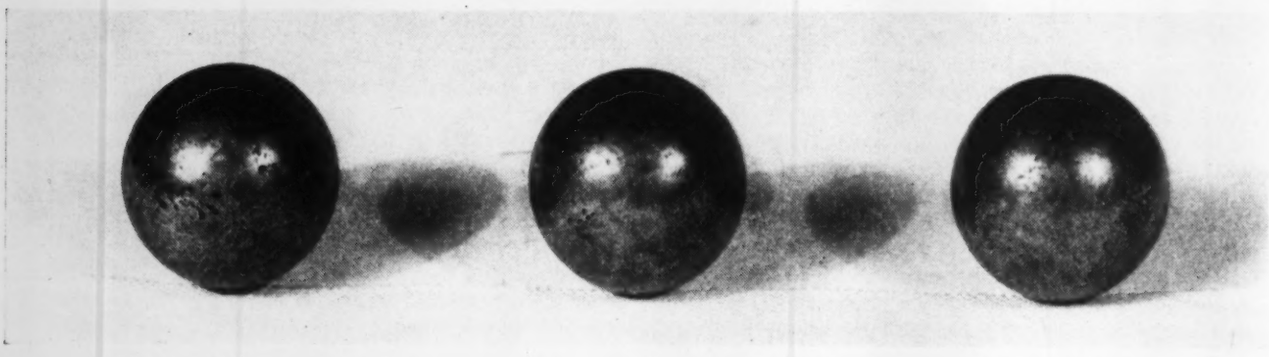


FIG. 4 CORROSION PITS IN BALLS FROM BEARING SHOWN IN FIG. 3

ability of a lubricant to protect the highly polished surfaces from rusting and to resist oxidation so as not to leave undesirable products in the bearing. Ball- and roller-bearing manufacturers universally recommend oils of high demulsibility for oil-lubricated bearings. As these oils separate from water rapidly, we find that excessive rusting of bearings has at times resulted from their use. It is extremely difficult to prevent a nominal amount of moisture from condensing inside a bearing housing.

Sodium soap, or blends of sodium soap with other soaps, will lubricate most grease-lubricated ball and roller bearings found in industrial equipment. This type of grease emulsifies with water and prevents rusting of the bearing. In extremely wet locations the lubricant may wash out of the bearing, in which case a water-resistant grease should be used.

Too much oil or grease will increase the running temperature caused by the churning of the lubricant. This condition is easily rectified by draining and restoring the proper amount of lubricant in the bearing; however, if this does not lower the temperature, most likely the bearing has locked, and the journal is turning in the bore, or the outer race is spinning in the housing.

In spite of educational work in the field, cases of overlubrication still occur. In oil-lubricated bearings, we prevent overlubrication by installing lubrication devices which automatically prevent the oil level from reaching a point where excessive churning of the oil will result. This churning results in a high temperature which coupled with atomization rapidly accelerates the oxidation of the oil with consequent detrimental results to the bearing. At times it is necessary deliberately to overlubricate in order to seal out dirt and moisture, or to scavenge the bearing.

Under similar operating conditions, we experience a wide variation in the life of these bearings. Frequently, the shortened life is attributed to faulty lubrication whereas it is generally the result of mechanical conditions such as misalignment, improper fits, contamination, or shock loads. Therefore, a careful analysis should be made of bearing failures.

EVALUATION OF LUBRICANTS

In a lubrication program it is necessary to specify a complete range of lubricants to meet the variety of conditions in any particular plant. Great care must be exercised in selecting lubricants by specifications. Evaluation of lubricants should only be attempted with a thorough understanding of the relative values of the various physical characteristics, the performance tests in service, and the characteristics which are inherent in the different blends and refining methods.

At present, stress is laid on the initial physical characteristics such as viscosity, viscosity index, flash, carbon residue, pour, and steam emulsion number. However, a lack of consideration is given to changes which take place in these physical characteristics in service.

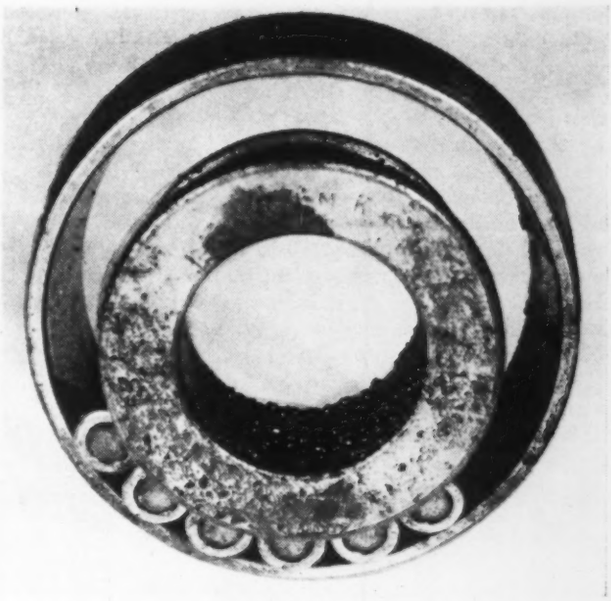


FIG. 5 CORROSIVE EFFECT ON A ROLLER BEARING OF GASKET, OIL, AND MOISTURE MIXTURE

Many new lubricants have been developed to meet the high temperatures and pressures in such equipment as superimposed turbines, Diesel engines, car and truck hypoids, rolling-mill equipment, and some hydraulic systems. Such lubricants when new may or may not differ in physical characteristics from lubricants available several years ago. They do, however, usually follow a different pattern of physical changes during service. Improved refining methods have tended to minimize carbon and asphaltic deposits in high-temperature operation and to reduce the quantity of sludge deposits in circulating systems. Our experience indicated that certain lubricants refined by some of the newer methods are lacking in oxidation stability, film strength, or load-carrying ability, as well as corrosion resistance. These shortcomings are often met by additions to the oil in the form of oxidation and corrosion inhibitors, and in some cases by the use of oiliness additives. There are many of these agents and they are hard to identify. The use of this type of lubricant presents many problems. For the purpose for which they have been designed, they function well. However, these are special lubricants for special purposes. If used indiscriminately under a wide range of operating conditions, they present a confusing performance picture. This is because some of these addition agents are water-

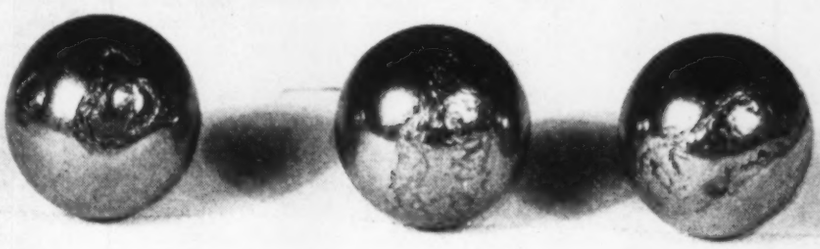


FIG. 6 SPALLED BALLS FROM A BEARING FAILURE CAUSED BY FATIGUE

soluble and may be washed out either in service or in some types of filters. Others are absorbed by selective types of filters; while still others lose their effectiveness during service. These properties make the reclaiming and reuse of such lubricants inadvisable.

The following example shows the need for care in evaluating lubricants from physical characteristics. For this purpose a solvent-refined inhibited oil will be compared with a non-solvent-refined oil, both of turbine-oil quality, on an Underwood bearing-corrosion test. Briefly, this test submits bearing inserts to an atomized spray of the oil under test at elevated temperatures. The loss or gain in weight of the bearing insert is a measure of the corrosive effect of the lubricant.

The standard test was modified by substituting ball bearings in place of the bearing inserts, and the addition of distilled water to the oil to simulate operating conditions. The data are reported in Table 2.

TABLE 2

	Solvent-refined oil and moisture		Non-solvent-refined oil and moisture	
	New oil	Used oil, 20 hr	New oil	Used oil, 20 hr
Saybolt viscosity, 100 F	546.2	...	553	...
Saybolt viscosity, 210 F	64.0	72.2	66.2	90.9
Viscosity index	88.6	...	96.4	...
Flash/fire	455/515	...	465/525	...
Gravity	27.0	...	28.4	...
Conradson carbon	0.46	1.39	0.44	2.48
Neutralization no	0.011	2.23	0.00	5.61
Naphtha insoluble	...	0.036	...	0.035
Chloroform insoluble	...	0.021	...	0.018
Bearing loss in weight, mg.	...	10	...	2
Volume precipitate	...	30	...	24.5

From a comparison of the change in viscosity, neutralization number, and carbon residue of the solvent-refined oil, with the non-solvent-treated oil, it is indicated that the solvent-refined oil was superior to the other product. Both oils show almost the same amount of breakdown as measured by the naphtha and chloroform insolubles. However, in this case we selected the non-solvent-refined oil because it affords greater protection to ball bearings in the presence of moisture as indicated by the lower loss of weight. If moisture could be eliminated, the solvent-refined oil would be of interest. Some solvent-refined oils have been successfully inhibited against corrosion of this type.

In order to predict more accurately the performance of a lubricant in service, it is often necessary to use a variety of established tests, modifications of them, or even in some cases, to develop new tests in the laboratory which will simulate the service requirements. We take laboratory tests as an indication, but check with actual tests in service over a long period of time before accepting a lubricant for general plant usage.

In testing lubricants the appearance of the parts to be lubricated in most cases shows whether or not mechanical wear has occurred, or whether the lubricant has left undesirable products in the system. Appearances are hard to describe, individuals differ when viewing a test, and no permanent record is available. We therefore use photographs as a means of providing a permanent record of the physical appearance of equipment before and after tests.

MANUFACTURER'S RECOMMENDATIONS

We find machinery name-plate data giving physical characteristics and type of lubricant recommended extremely helpful in the furtherance of our lubrication program. Further assistance is given by manufacturers who specify, on the machine name plate, what procedure should be followed in the care and operation of lubricating devices. Through this method, the machine operator, oiler, and supervisor are constantly reminded of the importance of maintaining proper lubrication. Information contained in instruction booklets too frequently finds its way to office files where it is no longer readily available to the persons most interested.

We find that the practice of equipment manufacturers in specifying lubricant by brand names, on the name plate of equipment, in operating instructions, or through verbal recommendation of erecting engineers, tends to interfere with a program such as ours where we are endeavoring to standardize lubricants. Prejudices often develop among the operating personnel through knowing what brand the manufacturer specifies. Further delay in standardization is brought about by the necessity of obtaining specifications or physical characteristics through analysis of the recommended product.

In many instances, operating conditions are such that operating efficiency of the equipment may be improved by deviating from the type of lubricant recommended by the manufacturer. As an example from our own experience, the lubrication of flexible couplings can be taken as an instance of the need for selecting a lubricant to meet the conditions, even though it does not correspond to the manufacturer's recommendations. In this case a particular brand of grease was recommended. All greases are merely mixtures of soap and oil, in which case the soap will separate from the oil in time, when the centrifugal forces of the coupling are sufficiently high. This separation permits the oil to leak out of the coupling and the remaining soap packs hard in the flexible members, causing a loss of flexibility. This loss of flexibility caused a turbogenerator to vibrate to such an extent that it was necessary to take it off the line and clean the coupling. When the alignment of the coupling is not perfect, the flexible members wear, as the soap is not a lubricant. We have therefore standardized on a heavy oil. This type of lubricant will not undergo physical changes from centrifugal forces present in industrial equipment. Some leakage is encountered so that suitable oil guards and pans must be provided to prevent oil spatter. Leakage is less troublesome than soap separation.

CONCLUSIONS

Our controls have reduced loss of product through contamination, loss of production through machine shutdowns, mechanical-wear corrosion, and cost of lubrication.

Experience has shown the necessity for thoroughly investigating and evaluating all known factors and searching for the unusual influences affecting lubricants when judging their performances.

From our experience we believe that lubricants from all sources and refining methods have both good and bad features. By blending and refining, emphasis can be placed on any desired characteristic at the sacrifice of some other properties. The tendency to minimize or entirely disregard the undesirable properties is likely to lead to some misconceptions in evaluating lubricants.

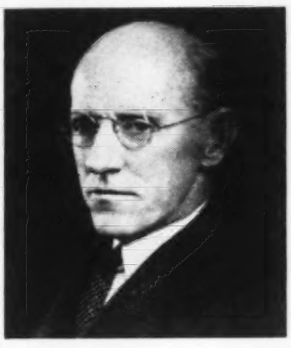
Further cooperation between designers, users of mechanical equipment, and refiners of lubricants will result in the establishment and furtherance of standard practices, in conformance with good lubrication principles, based on a thorough understanding of the physical limitations of lubricants. This will be of particular value toward furthering a program such as ours.

There is a need for accelerated laboratory tests of lubricants which will correlate with service tests.

In conclusion we wish to acknowledge the aid received in the furtherance of our program from the equipment builders, oil refiners, and members of our company, especially to Messrs. H. F. Smith and I. S. Bradley.

R. E. DOHERTY TO HEAD E.C.P.D.

The Engineering Institute of Canada Joins Council



R. E. DOHERTY

AT THE 1940 annual meeting of the Engineers' Council for Professional Development, held on October 24 at the University Club, Pittsburgh, Pa., Robert E. Doherty, president, Carnegie Institute of Technology, was elected chairman and Harry T. Woolson, executive engineer, the Chrysler Corporation, member A.S.M.E., was elected vice-chairman. George T. Seabury, secretary of the American Society of Civil Engineers, becomes the E.C.P.D. secretary and H. H. Henline, secretary of the American Institute of Electrical Engineers, assistant secretary. The other officers elected at the Pittsburgh meeting are A. A. Potter, past-president A.S.M.E., chairman of the Committee on Schools; C. F. Scott, member A.S.M.E., chairman of the Committee on Professional Recognition; R. L. Sackett, fellow A.S.M.E., chairman of the Committee on Student Selection and Guidance; S. D. Kirkpatrick, editor, *Chemical and Metallurgical Engineering*, chairman of the Committee on Professional Training; and E. R. Needles, of Ash, Howard, Needles, and Tammen, New York, N. Y., chairman of the Committee on Ways and Means.

A Committee on Information was also elected consisting of Sydney Wilmot, manager of publications A.S.C.E., chairman, and George A. Stetson, editor A.S.M.E.; G. Ross Henninger, editor A.I.E.E.; E. H. Robie, editor A.I.M.E.; S. L. Tyler, secretary A.I.Ch.E.; F. L. Bishop, secretary S.P.E.E.; L. Austin Wright, secretary The Engineering Institute of Canada; and Charles F. Scott. The Executive Committee will consist of R. E. Doherty, chairman, ex officio; E. R. Needles, A.S.C.E.; G. B. Waterhouse, A.I.M.E.; A. R. Stevenson, Jr., A.S.M.E.; James F. Fairman, A.I.E.E.; B. F. Dodge, A.I.Ch.E.; C. C. Williams, S.P.E.E.; C. F. Scott, N.C.S.B.E.E.; and J. B. Challies, E.I.C.

Because of the absence of J. P. H. Perry, chairman, and C. E. Davies, secretary, R. E. Doherty presided and George T. Seabury acted as secretary. The A.S.M.E. was represented by the entire delegation of its members on the Council, A. R. Stevenson, Jr., Harry T. Woolson, and R. L. Sackett.

THE ENGINEERING INSTITUTE OF CANADA BECOMES MEMBER OF E.C.P.D.

By unanimous vote of the Council, The Engineering Institute of Canada became the eighth participating body of E.C.P.D. A delegation of members of the Institute, headed by J. B. Challies, past-president E.I.C., was present. Mr. Challies, speaking on behalf of the president of the E.I.C., expressed the Institute's appreciation of the action by which it had become more closely affiliated with engineering bodies in the United States and announced the names of the Institute's representatives: J. M. R. Fairbairn, A. Surveyer, and J. B. Challies. He also introduced the other members of the delegation, Prof. C. R. Young, of the University of Toronto, who was appointed to the Committee on Professional Training; H. F. Bennett, who becomes a member of the Committee on Student Selection and Guidance; and L. Austin Wright, secretary E.I.C. James A. Vance, who was not present, will serve on the Committee on Professional Recognition.

COMMITTEE TO STUDY S.P.E.E. REPORT ON CURRICULA

At the request of D. B. Prentice, president S.P.E.E., member A.S.M.E., the report of the S.P.E.E. Committee on Aims and Scope of Engineering Curricula was referred to the Committee on Engineering Schools. This report was published in the October issue of MECHANICAL ENGINEERING under the title "Whither Engineering Education?" It was presented, discussed, and informally approved at the 1940 annual meeting of S.P.E.E. President Prentice explained that the question had been raised as to whether adoption by engineering schools of the principles and policies advocated in the report, many of which look toward "liberalized" curricula, would meet with the approval of the Committee on Engineering Schools, on whose recommendations engineering curricula are accredited by the E.C.P.D.

SACKETT REPORTS ON STUDENT SELECTION AND GUIDANCE

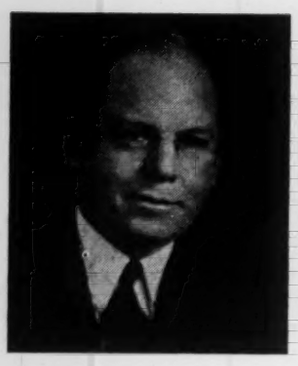
In an oral summary of the report of the Committee on Student Selection and Guidance, R. L. Sackett said that the committee had sought to continue its program of encouraging the national, state, and local engineering societies to organize committees to cooperate with high schools in guiding boys to make a wise decision when considering engineering as a career. The report he said, was to be considered as generally informative of what was going on in this field. He acknowledged the assistance given him by the secretaries of the national engineering societies in sending circular letters to local sections and committees on education asking for reports on guidance activities and said that the E.C.P.D. guidance manual had been revised. He also called attention to reports on guidance activities undertaken by the New York Engineers' Committee on Student Guidance, on which are members of A.S.C.E., A.S.M.E., A.I.E.E., A.I.M.E., and A.I.Ch.E., and many others had been serving, and to work of the Student Guidance Committee of the New York Section, A.I.E.E., and of the Engineering Society of Detroit, the Engineers Club of Omaha, and the Nebraska Engineering Society; and read excerpts from a "Suggested Procedure for Counselors of Vocational Education" on aids in counseling high-school boys, copies of which can be obtained from John R. Rippey, chairman, Omaha Engineers Club, Omaha, Neb. Other reports summarized by Dean Sackett described the work of the schools of Portland, Ore., the Colorado Engineers Council, and The Engineering Institute of Canada.

RECOMMENDATIONS OF COMMITTEE APPROVED

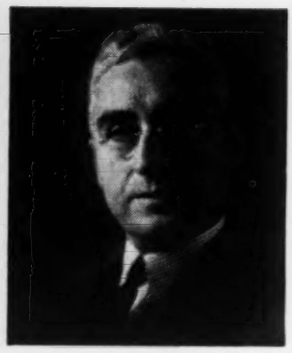
Three recommendations of the Committee on Student Selection and Guidance presented by Dean Sackett, thoroughly discussed by the Council, and subsequently approved, were:

1 In order to organize guidance in cities of 10,000 or more population, it is desirable that additional appeal be made to local interests. The effectiveness of guidance in the Metropolitan area, in Detroit, Milwaukee, Denver, Chicago, Omaha, and other cities is due to the initiative of some person or small group. Appeal through the societies has had its effect but still we need other lines of communications.

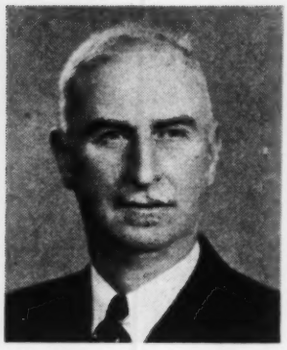
The committee requests that the E.C.P.D. approve the appointment of a subcommittee of the Committee on Student Selection and Guidance



HARRY T. WOOLSON



J. B. CHALLIES



J. M. R. FAIRBAIRN

ARTHUR SURVEYER

on "Organization of Guidance in High Schools." The subcommittee should consist of several men who are now active in this work, among whom should be some who are so located that they could energize the organization of guidance where it is not now active.

Closer affiliation with E.C.P.D. is either assumed or desired by some guidance committees. For instance, the Chicago committee signs itself "The E.C.P.D. Committee" for the Founder Societies and the Western Society of Engineers. James M. Comly, chairman of the A.I.E.E. committee, says in his report that Mr. Larkin (secretary of Joint Committee of Metropolitan Sections) "was also requested to investigate the possibility of having the joint committee sponsored directly by the Engineers' Council for Professional Development in order that it might have some standing in its own right." Such a subcommittee would serve to give a more direct line of communication between E.C.P.D. and local-section or city organizations for guidance without crossing the present lines from the national societies to their local sections. Local sections should and still would be the basis of organization where they see fit to function.

At present there is no method of recognizing the services to E.C.P.D. of some who have done worthy organizing work. Such a subcommittee would also serve that purpose.

2 "Engineering as a Career" is presented for your approval. It has been scrutinized by each affiliated society.

The committee requests that provision be made for its publication. For this purpose $4000 will be needed if it is to be illustrated and printed in attractive, durable form.

3 It is possible that financial provision may be made for a study (*a*) of tests and examinations which have proved to be most effective in the selection of students who are better equipped to achieve in college and in life, and (*b*) of devices designed to differentiate between engineering ability and nonengineering talent.

Through the interest of President A. R. Cullimore of Newark College of Engineering, who is a member of this committee, preliminary plans for possible cooperation between the S.P.E.E. and the E.C.P.D. in such a study have been made. A suitable college personnel officer who is familiar with this field is being sought. President Cullimore believes that he can find the funds necessary which are estimated at $4500. Such a critical analysis of various tests now in use and combinations of them would be of definite value to admission officers, to high-school counselors, to college personnel officers, and to engineering schools.

Publication of the guidance booklet "Engineering as a Career," was authorized, subject to review of the manuscript by the Committee on Information and availability of the necessary funds.

ESHBACH REPORTS FOR COMMITTEE ON PROFESSIONAL TRAINING

In presenting the report of the Committee on Professional Training, Ovid W. Eshbach, chairman, said that no recommendations were presented and no endorsement was asked. The report covered in general the two principal activities of the committee during the last year, the exploration of the possibilities for closer cooperation between the engineering schools and junior engineering groups, and the possibilities for closer cooperation between local engineering societies, colleges, and national engineering organizations, including E.C.P.D.

As the result of a meeting of the Committee in New York on January 23, 1940, at which pamphlets, circulars, and posters that have been used to advertise the educational facilities available in various cities were studied, it was decided to sponsor publication and distribution of a poster listing the principal fields of instruction and the educational institutions in the New York area at which these engineering, science, business, economics, and English courses were available. The poster, of which 4000 copies were printed, was prepared by a committee consisting of Harry J. Masson, New York University, Arthur L. Cooke, Pratt Institute, and A. R. Cullimore, Newark College of Engineering.

WHAT SECTIONS ARE DOING IN PROFESSIONAL DEVELOPMENT

Dean Eshbach reported that the A.I.M.E. and the A.I.E.E. had sent to their local sections questionnaires asking what had been done in postcollege student guidance. The replies are summarized in the report, and the following conclusions have been drawn:

It is apparent that sections, as a whole, have not developed a special program for the development of junior engineers. It is also apparent that each section is a specific case and that any general program must fit into the conditions each section encounters.

Opinions about specialized activities for junior engineers are not positive as to its need, its value, or its reception by junior engineers. It seems obvious that the start of any such work can best be made by having junior engineers participate more actively in regular section activity. Organized efforts to bring about personal contacts, to get young engineers on committees, to develop some form of paper competition or debates, and to stimulate them to discussion at section meetings will bring results, and possibly, except in special cases, this is as far as sections can and should go in this work.

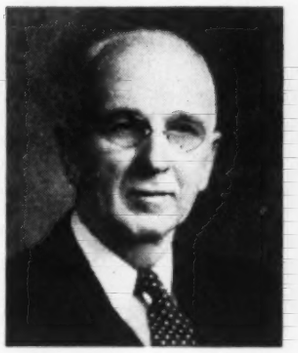
Efforts of sections to give educational work directly do not appear to be warranted because of the availability of courses already being given by educational institutions, and it seems more advisable for sections to stress the social and professional aspects of their development by having them participate actively in regular section activities.

In large metropolitan sections the forming of groups of engineers within the section works well, although these groups usually are not restricted to junior engineers but are classified as power, communication, transportation, or other types of engineers. However, these small groups do facilitate more active participation by junior engineers.

At the other extreme is the section that covers a large area having only a few junior engineers. In this case little can be done except to have the junior engineers attend and participate in regular section meetings.

Experience indicates that one or two meetings in each year may be adapted to the junior engineers' development. Possibly a speaker of great engineering experience to discuss the broader aspects of the profession, possibly a joint program with a paper by a senior and a junior engineer, possibly a prize paper competition or debate—it all depends upon conditions—but replies indicate that such programs are welcomed by junior engineers.

Inspection trips are welcomed by junior engineers yet they find it



C. R. YOUNG

H. P. BENNETT

L. AUSTIN WRIGHT

JAMES A. VANCE

difficult to get away from the job to make the trips and care should be exercised in selecting the time to make the trips.

One of the best systems discovered lies in having a senior engineer sponsor a junior engineer. The senior engineer takes the junior to the meeting with him and often invites him to dinner before the meeting and serves as a counselor to the junior. Within limits, this seems to be a splendid activity for sections to cultivate.

In conclusion, there is no doubt that sections are more active in work to develop young engineers and are more conscious of their obligations and opportunity. Undoubtedly, progress will be made even though it is evident no startling or extraordinary program will be developed or used.

Dean Eshbach also announced that the Committee's "Self-Appraisal Blank" and its "General Reading List" were to be revised. When these are republished, it is his recommendation that they be issued separately and not as one pamphlet as at present.

SCOTT REPORTS FOR COMMITTEE ON PROFESSIONAL RECOGNITION

C. F. Scott presented the report of the Committee on Professional Recognition, a document dealing largely with suggestive comments directed to the question "What is professional recognition?" and difficult to summarize briefly. The following recommendations were made:

1 E.C.P.D. should urge upon its participating societies a study of the engineering profession, including its present status and proposals for its development. (It is suggested that this may include papers, discussions, and reports, sponsored by the societies individually or in collaboration.)

2 E.C.P.D. should urge upon its participating societies that their student groups be encouraged to become informed and interested in a study of engineering as a profession, including its present status and its development; also the field of professional ethics. (It is suggested that studies similar to that of the A.S.M.E. may be serviceable.)

3 E.C.P.D. should urge that the S.P.E.E. interest its members in seeing that engineering students become acquainted with professional ethics, organization, and registration.

4 E.C.P.D. should urge state registration boards through the N.C.S.B.E.E. to increase the present emphasis on character, social motivation, and understanding and practice of professional ethics in qualifying candidates for registration.

A review of current activities in the field of professional recognition was also a feature of the report.

POTTER REPORTS ON ENGINEERING SCHOOLS

For the Committee on Engineering Schools, whose principal function has been the accrediting of curricula, Dean A. A. Potter summarized the report. Incident to its accrediting program the committee has given advice informally to schools requesting it. As of Oct. 20, 1939, curricula to the number of 433 had been accredited unconditionally, 82 for a limited period, and 172 had not been accredited. During 1939-1940 visits were made to 22 institutions for the purpose of reinspecting 70 curricula on the accredited list, and 17 institutions were visited in order to appraise 32 curricula not on the accredited list. As of Oct. 24, 1940, the record stood as follows: Total curricula submitted, including reinspections, 791; accredited unprovisionally, 457; accredited provisionally, 83; not accredited, 164; reinspections resulting in no change in status, 82; action pending, 5.

The report dealt also with progress made by the committee in the solution of specific problems, such as specialized curricula and options in accredited curricula, some of which are not listed; evening and cooperative curricula, on which a statement of policy was presented; curricula in chemical engineering and in agricultural engineering; the suggested accrediting of curricula in technical institutes; the reduction of irritations incident to accrediting; and the extension of the accrediting outside of the United States.

Mention was also made of the special study, published a year ago, on trends in engineering education, prepared by D. C. Jackson, and attention was directed to the problem of financing the accrediting program. In discussing future activities the report stressed particularly the reinspections of accredited curricula, the financing of the reinspection program, and the committee's aim to effect better coordination of accrediting agencies.

In a closed session which followed the general meeting of the Council, the recommendations of the Committee on Engineering Schools in respect to specific curricula were considered. A revised list of accredited curricula has been issued by the committee which includes the actions taken at this session.

E.C.P.D. TO PARTICIPATE IN 1941 A.S.M.E. SEMI-ANNUAL MEETING

An invitation to E.C.P.D. to participate in the 1941 Semi-Annual Meeting of The American Society of Mechanical Engineers, to be held at Kansas City, June 16 to 20, signed by the chairman of the local committee, Linn Helander, was read by Dean R. A. Seaton of the Kansas State College of Agriculture and Applied Science. The invitation was received with expressions of appreciation and the details of working out a program were referred to the chairmen of the four principal committees of E.C.P.D. with coordination to be effected by R. E. Doherty.

TALKS AT ANNUAL DINNER STRESS PUBLIC RELATIONS OF ENGINEERS

By far the largest annual dinner of E.C.P.D. was held in the dining room of the University Club on Thursday evening with Chairman R. E. Doherty presiding and several talks by prominent engineers on various phases of the public services of engineers. Chairman Doherty announced, with an acknowledgment of E.C.P.D.'s gratification, the affiliation of The Engineering Institute of Canada with E.C.P.D., an event, he said, that represented the growing realization of the community of

interests that exists between the United States and Canada. He also expressed the regret of the Council at the absence, because of illness, of J. P. H. Perry, chairman E.C.P.D.

Dean Potter delivered a brief address, to be found on pages 901–902, entitled "Government and the Engineer."

PREPAREDNESS AND THE ENGINEER

S. D. Kirkpatrick, editor, *Chemical and Metallurgical Engineering*, spoke on "Preparedness and the Engineer." He recalled President Wilson's saying that the sinews of war are men, money, and munitions, and then proceeded to add mobilization of manufacture, machinery, materials, metals, management, and morale to this alliterative combination. Preparedness, he said, had become the nation's No. 1 industry inasmuch as a 10- to 12-billion-dollar preparedness program had been saddled onto the normal peacetime production of the United States.

The fortunes of war, he recalled, were, in Lloyd George's words, decided in the workshops and laboratories of the country. He stated that Germany's preparations had bogged down at one time because of the lack of trained engineers and skilled workmen, but that Germany had succeeded in eliminating these bottlenecks. There was presented in the United States today to all engineers more than a duty, an opportunity as well, to serve in the national defense. How he should serve was a question each man would have to answer for himself. One obligation was to help other men, through training and skilled management, to be of greater service to the nation.

He referred at length, with appropriate quotations, to an article in *Harpers* for October, by Carl Dreher, in which it is pointed out that Germany is engaged in "technological politics," and what the implications of this technique are. An important responsibility occasioned by rapidly expanding production was placed on engineers in the successful management of national-defense enterprises. He paid tribute to the people of Canada and to the work of the Canadian Minister of Munitions, C. D. Howe, a civil engineer. He also reminded his audience that compulsory registration of engineers had been resorted to in England, and that a voluntary registration in the form of a National Roster was in progress in this country. A stirring tribute was uttered in recognition of the engineers in the United States engaged in the national-defense program, and the fact was emphasized that these engineers thought in terms of production and not of politics. Of the great national needs of today, he concluded, technically trained man power comes first.

PREPAREDNESS AND THE CANADIAN ENGINEER

Speaking on behalf of The Engineering Institute of Canada on the subject "Preparedness and the Canadian Engineer," Prof. C. R. Young, of the University of Toronto, prefaced his brief address by expressing the satisfaction of the Institute in the honor that had been conferred upon it by its affiliation with E.C.P.D. He paid tribute to C. D. Howe, mentioned by Mr. Kirkpatrick, and other engineers who were defending Canada and the British Empire.

The great problem of E.C.P.D. as he saw it was the welfare of the engineering profession. The central fact that, in his opinion, justified recognition of engineering as one of the learned professions was the trust that was implied in the practice of engineering, whether performed for salary or for fee. It was essential, he said, for the employer or client to trust the engineer, just as he trusts his lawyer or his physician. Because of this element of trust in the relationship between client or employer and the engineer, it should be understood that we can go only so far in improving the welfare of the profession through legislation and organization. Good material with which to construct a body of professional men was essential. The welfare of the engineer was a matter of the individual stature of the engineer.

In this connection he read the following excerpt from a letter of Lindsay Russell, at one time Surveyor-General of Canada, written about 1878:

> The only legitimate means of raising the status of the profession consists in the effort of each individual thereof, by the evidences of conduct, acquirements, and ability, to win for himself the good opinion of those of his fellow-citizens with whom he comes in contact. The more as individuals the members of any profession succeed in this, the higher as a class they will stand. If as a class they are held in slight esteem by the public, it is because they do not merit more. Public opinion is, on the whole, tolerably just, and no doubt rates the services of any class at their true value. I am afraid we will have to rest content with being of no more importance in the eyes of our fellow-creatures than the circumstances of our own merits, and the value of our services to them, have combined to prescribe.

INDUSTRY AND THE ENGINEER

Announcing that he was not an engineer but that he had many opportunities to deal with many engineers and with young engineers, E. B. Roberts, assistant to the vice-president, Westinghouse Electric and Manufacturing Company, spoke on "Industry and the Engineer."

A majority of the leaders in his company who were engaged in heavy manufacturing were engineers, he said, and the heavy present demand for expansion in the national defense would fall on these men. Although industry had done a good job in training young engineers in the technical phases of their work which had advanced them to executive levels, it had not, in his opinion, done so well in training them to manage the mixed functional groups, which include many nonengineering interests. He paid tribute to the engineer as a straight thinker who was able to analyze a problem, find a solution, and put it to work, and to the E.C.P.D. and the S.P.E.E. which were concerned with improving engineering education and training. Let nothing be done, he said, to injure, curtail, or impair engineering training in this country. It should be the policy of the nation, he asserted, to conserve this industrial human material. America, he concluded, was in the hands of engineers, and engineers were in the hands of engineering educators.

SOCIETY AND THE ENGINEER

The concluding address of the dinner was delivered by John G. Bowman, chancellor of the University of Pittsburgh, who spoke on "Society and the Engineer." Chancellor Bowman said that the engineer was made up of about 75 per cent scientist and 25 per cent humanist and contrasted the methods of the scientist and the humanist. The scientist, he said, avoids logic and bookkeeping. He is motivated by curiosity. He finds something and says, "Here it is. You've got to take it." His attitude is the attitude of command. On the other hand the attitude of the humanist is one of entreaty. Of his discoveries he says, "Here it is. If you could only get it you would feel as I have that you have lived." In this regard Shakespeare was the greatest humanist; and Chancellor Bowman presented many examples from the playwright to prove his point. There was in the humanist attitude the demonstration of the quotation "There is some soul of goodness in things evil, would men observingly distil it out." Thus Homer inspired the Greeks to courage by reciting their courageous exploits, and David the Hebrews to faith by means of the Psalms. The humanist attitude was coming into engineering, he said, and "tonight's program could not have happened" some years ago. The engineer, he said, was becoming a combination of the hardheaded scientist and the humanist.—G.A.S.

GOVERNMENT *and the* ENGINEER

By A. A. POTTER

DEAN OF ENGINEERING, PURDUE UNIVERSITY

THE welfare of the engineering profession is now more closely tied up with government than ever before. Municipalities, states, and the federal government are constantly carrying on a variety of engineering operations and are becoming concerned to a very large extent with the regulations of engineering enterprises and in many cases with the operation of technical industries as well. However, the influence of engineers on government has not been in the past as great as it should have been, when one considers that the problems of government are largely technological in character. We have in our country a large number of engineering societies to serve our specialized interests. Our profession has also set up several functional organizations which are intended to serve our mutual technical objectives.

One of these organizations, the Engineers' Council for Professional Development, has been endeavoring to insure to the public better prepared as well as more competent engineers. Another, the Engineering Foundation, has been successful in fostering high-grade engineering research. Still a third functional agency, the N.C.S.B.E.E., has been a most important factor in giving national scope to licensing laws for engineers. We have, however, failed to support our only public-affairs mouthpiece, the American Engineering Council, which was created by our profession to relate the engineer to government. It is feared that the engineer's influence in government and in public affairs will remain insignificant, unless our various engineering societies are willing to support one functional agency of our profession which is able to present a united front in matters pertaining to government. Washington needs during the present emergency one spokesman for the engineering profession and not separate competitive mouthpieces for different specialized engineering societies. Are we willing to admit that we lack ability to organize in the interest of public welfare during this emergency?

GOVERNMENT'S NEED FOR ENGINEERS

Engineers in the past have been largely associated with private enterprise and there has been a considerable tendency on the part of some members of our profession to depreciate government service for engineers. We engineers must change our mental attitude about employment in government service, particularly in view of the present most friendly attitude of the U. S. Civil Service Commission toward engineers for major posts in government. We must also take a much more active interest in public affairs. It must be realized that the national-defense program, which we are now organizing, will require for its effectiveness large numbers of engineers skilled in a wide range of technical and administrative services. In fact, the success of this undertaking will depend very largely upon the extent to which our government can command expert engineering talent to serve during the emergency. There is an acute shortage of technical and supervisory engineering personnel not only in the industries concerned with national defense but also in the Army, Navy, and other defense agencies of government. By an Act of Congress, approved on Oct. 9, 1940, $9,000,000 were turned over to the U. S. Office of Education, the regular defense agency of government which has cooperated with higher education for many years, for the purpose of increasing the supply of engineering specialists. It is impractical and undesirable to speed up the regular engineering collegiate programs of study, but the appropriation referred to will make it possible for engineering schools to utilize their special facilities in the following ways:

1 Institutions which are located in large industrial centers, such as Pittsburgh, will be encouraged to offer in-service training courses of special value in up-grading the supervisory and the technical personnel of defense industries in its locality.

2 Institutions which are removed from industrial centers, but which have outstanding engineering staffs, will be encouraged to develop certain types of in-service training on the engineering-college level through extension classes.

3 Intensive resident programs of study, varying in duration from one to several months, will be set up in a number of engineering schools which have outstanding facilities in staff and equipment, to retrain engineers for certain specialized fields of special value to the defense program.

A regional organization is now being developed so that the needs of industry and of government for engineering talent may be coordinated with the facilities available in engineering schools for training of a specialized type. It is hoped that the engineering in-service and intensive training programs which are now being organized will prove helpful in supplying the urgent needs for engineers in the rapidly expanding defense industries as well as for the defense agencies of government, but without disrupting the regular curricula which lead to degrees in engineering.

STABILITY OF GOVERNMENT ESSENTIAL

As engineer-citizens we must realize that government is an essential part of our existence and that our usefulness as engineers depends very largely upon the stability of our government. No one can predict what the future will hold for us. I am, however, one of those who has faith in the American form of government and who is fully convinced that the United States is a land worthy of our best endeavors and of the most loyal patriotism in peace or in war. Any one of you who feels unhappy because of the present conditions in our country will do well to compare, without political bias, our government with the totalitarian, or gangster rules, of other lands. Place in one (left-hand) column the ideals for which the government of the United States stands, such as, truth, right, liberty, law, equality of opportunity, humanity, and government by consent. Set down in the other column what one finds in totalitarian lands. You will have to write down in the right-hand column not truth but lies, not liberty but slavery and obedience to mediocrity and tyranny, not law but arbitrary authority by gangsters, not equality of opportunity but privilege limited to members of the gang, not humanity but cruelty, and not government by consent but government by cruel and dishonest dictatorship. Our American system has been able to provide comforts and even luxuries for our people to a scale unheard of in other lands, not through banditry or through the confiscation of the property of individuals or peoples, but by encouraging on the part of the citizens of our country freedom from revolu-

An address delivered at the 1940 Annual Meeting, Pittsburgh, Pa., Oct. 24, 1940, of the Engineers' Council for Professional Development.

tionary worries, industry, and the maximum development of their creative talents.

HOW ENGINEERS CAN PROTECT AMERICA'S FUTURE

During these difficult times we as engineer-citizens can protect the future of our country in the following ways:

1 We must do everything in our power to aid in speeding up the defense program of our government, by giving our best talents to problems which will insure adequate and speedy production of the very best implements of war. This country is responsible for more than two thirds of the epoch-making inventions of our times. Let us use our creative abilities as engineers to build up our defense equipment so that we are fully insured against war. Remember the German war machine represents expenditures which in terms of our system of fairness and not banditry would cost more than 100 billion dollars. However, our expenditures for defense should be an insurance against war and not for the purpose of waging war, except in the gravest and proved national emergency.

2 We must give our support to the selective draft. It should be realized that the best mechanized equipment is useless unless we have men who have military as well as technical knowledge, and who possess qualities of physical endurance as well as of technical skill. Even the selective draft will give us an army of about 33 divisions as compared with 250 divisions in Germany.

In discussing the selective draft with our friends of draft age let us impress upon them that no autocratic group in Washington but their own neighbors are members of the draft boards who have the responsibility of deciding which men are to be called, or deferred because of civilian activities or dependents. These boards have been advised in volume 3 of Selective Service Regulations that "it is in the national interest and of paramount importance to our national defense that civilian activities which are contributing to the national health, safety, and interest should be disrupted as little as possible, consistent with the fundamental purpose of the Selective Training and Service Act." Also a registrant is to be considered for deferment if he is "a necessary man" in industry, business, employment, agricultural pursuit, governmental service, or in any other service or endeavor, including training or preparation therefor, *only when all of these conditions exist:*

(*a*) He is, or but for a seasonal or temporary interruption would be, engaged in such activity.

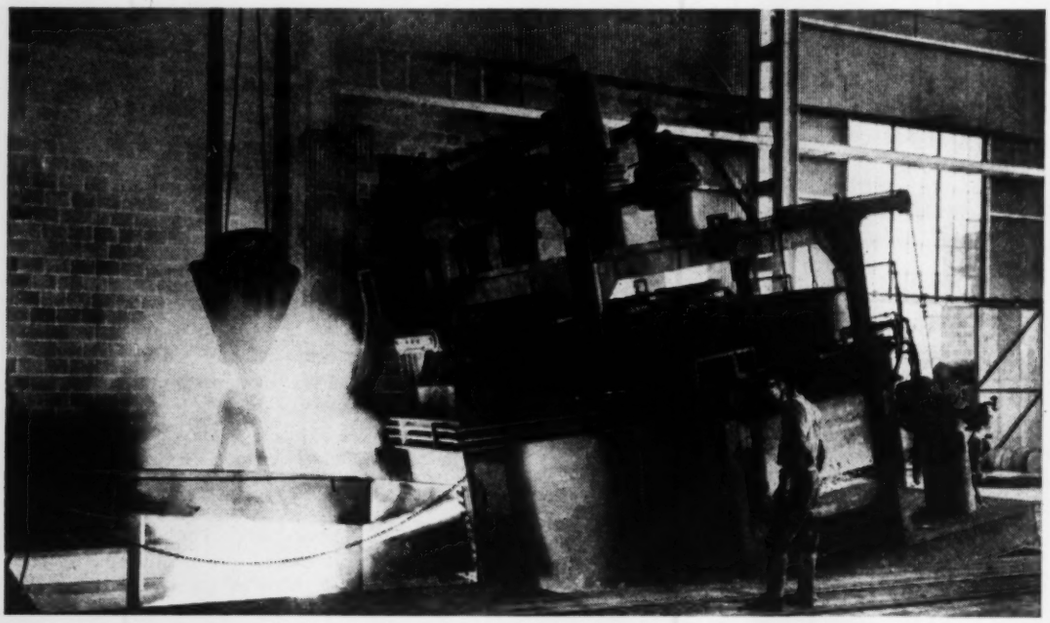
(*b*) He cannot be replaced satisfactorily because of a shortage of persons with his qualifications or skill in such activity.

(*c*) His removal would cause a material loss of effectiveness in such activity.

Dependency deferments are particularly liberal. While peacetime draft is distasteful to many of us we must realize that in the present national emergency the Selective Service Act was approved by a large majority of our representatives in Congress, and as patriotic American citizens it is our duty and responsibility to uphold this Act of Congress which is now the law of our land.

3 We must realize that Great Britain is fighting our common enemy and should be given every possible assistance, short of actual warfare, in exterminating the worst gangster bands of all times. This can only be done if we are wise and courageous enough to stay out of war. For our country to be drawn into a war at this time will prove most detrimental to the future of all democracy.

4 We must bring about greater unity among our people. Foreign propaganda constantly at work even in our own land, supplemented by partisan political intrigue, have been responsible for developing extreme class, race, color, and creed consciousness. Let us do everything in our power to discourage such un-American efforts and let us retain the qualities of tolerance, humanity, and equality which have characterized our people at all times. Let us, as engineer-citizens, not forget that we are fortunate to live in a land where nonconformity with the views of government does not threaten us with death or concentration prison, where individual liberty is still considered sacred, where there is true equality of opportunity, where one is free to accept or change employment, where there is still considerable respect for the integrity of contract, and where the individual, more than in any other land, has full right to life, liberty, and the pursuit of happiness.



TAPPING ONE OF THE FIVE ELECTRIC FURNACES IN THE NEW MELT SHOP OF RUSTLESS IRON AND STEEL CORPORATION, BALTIMORE, MD.

The LOCATION *of* INDUSTRY:[1] LAISSEZ FAIRE *or* CONTROL?

By DWIGHT L. PALMER

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

THERE is evidence that a growing segment of American thought is interesting itself in the rationale of industrial location. The growth of the doctrine of regionalism, studies of locational factors, analyses of the geographic distribution of particular industries, frequent stress on the concept of "planning," the emerging concept of "defense areas"—all bear significant witness to our increasing preoccupation with *order* in the spatial relationships of machines, materials, and markets, of management and men.

The enthusiasm with which many English writers have recently explored the same subject suggests that this interest in the basis of industrial location is one we hold in common. In a recently published volume, "The Location of Industries and the Depressed Areas,"[2] S. R. Dennison has summarized British experience in this field and has analyzed certain aspects of the problem in terms general enough so that an examination of his findings in relation to current American practice may provoke thought and discussion, although his conclusions may not win unqualified acceptance.

At the outset, Professor Dennison makes it clear that he is not concerned with a "general" theory of location applicable in all countries at all times, but rather with an analysis of those specific locational factors important in observed British cases. Thus, no arbitrary list of factors is set forth; indeed, the author holds that such a procedure is so fraught with difficulties that it is of dubious wisdom in any case. Instead, all elements, rational or irrational, are given their appropriate weight based on their proportionate significance as segments of the cost of production.

It is contended that the postwar years have considerably altered the relative strength of the classic factors of location. For example, the growth of the grid system of electrical distribution has freed heavy power users from their former ties to the coal fields. Transport costs are less because of increased flexibility of truck and rail and, more particularly, because of the increasing preponderance of light, highly refined products consumed in a mature capitalist economy. Furthermore, systems of delivered prices for such items as iron and steel parts reduce the emphasis on locating near raw materials. Then, too, a supply of suitable labor in the sense of skilled artisans no longer exerts as strong an influence on location as formerly. Industrialization shortens the training period, if not for the craftsman, at least for the skilled and semiskilled laborer. A suitable supply of man power now tends to mean " . . . adaptable and relatively inexpensive, rather than highly skilled labor." Although the presence of trade unionism may be a factor, it can easily be overstressed.

In contrast, certain factors appear to be gaining strength in determining British industrial location. Of these, nearness to market appears of primary importance. This, however, is no longer mainly a transport problem. Rather, the facilitation of full and rapid consumer service is now the crucial need, as demonstrated by the depots, supply stations, and branch plants located near the customer whether he is a final consumer or another industrialist in the production process. Then, too, many heretofore relatively insignificant items have come to exert increasing collective pressure now that such nineteenth-century factors as transport and labor are of less decisive influence. These matters of growing importance include such considerations as the publicity value of a factory visible from a main highway, healthy surroundings of rural areas, peculiarities of city tax structures, or the pressure of local interests such as development boards. Owing to the greater weight attached to such "marginal" elements the writer concludes that ". . . there is now a wider range of choice in location than formerly."

Certainly, much of this appears readily applicable to the roughly equivalent American problem. The remainder of the book under review, however, is concerned with an approach to locational problems which bears a definitely British stamp, and which, in its more overt forms at least, has yet to be seriously contemplated on this side of the Atlantic.

As Britain has matured, a process of social "metabolism" has led to the growth, expansion, and prosperity of some regions, and an accompanying shrinkage and depression of others. These latter regions of high unemployment and capital stagnation have tended to be one-industry localities where a downward economic cycle has wrought havoc and resulted in long-continued dislocation, because these regions, lacking industrial diversity, found themselves in time of need possessing no secondary lines of defense. This problem is well illustrated by the plight of Lancashire when disaster overtook its one major industry, cotton textiles.

Once a region begins to decline in this manner, many apparently self-generating forces intensify the general trend. As some firms fail, the tax rates on the remainder rise. Capital, having sustained a loss in the locality, is wary of further local investment. The more energetic business leaders, mindful of local disaster to a former colleague, migrate to rapidly expanding and more prosperous areas. Skilled labor, anticipating long unemployment as a result, departs for busier sectors of the industrial front. The local community, uncertain of the future, allows its schools, roads, hospitals, and other amenities to go unrepaired. Thus physical deterioration is added to economic stagnation.

By 1934 these depressed localities had come to be regarded as a "national" problem. It was rather generally agreed, further, that, whereas many promising techniques of treatment were available, locally generated improvement schemes were palpably inadequate. A moment's consideration will reveal two major lines of thought in this British development. First, certain regions called "special areas" (rather than "depressed" because of public animosity to the latter term) are held to be in need of individualized treatment as a means toward restoring them to economic vigor and enabling them once more to function properly within a balanced national scheme. Second,

[1] One of a series of reviews of current economic literature affecting engineering, prepared by members of the department of economics and social science, The Massachusetts Institute of Technology, at the request of the Management Division of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Opinions expressed are those of the reviewer.

[2] Oxford University Press, London, 1939, 216 pp.

a whole battery of techniques (private and public) is declared to be available for the successful rehabilitation of the special areas but only on condition that strong governmental backing and supervision are provided.

Following the growth of public interest in the problem, Parliament passed the Special Areas Act in 1934, setting up fact-finding, administrative bodies to propose and carry out unified action by which to restore, if possible, the special areas. Surveys were conducted under the coordinating direction of the Commissioners for the Special Areas and remedial action along the lines of these proposals was instigated. The areas were made livable and even inviting by the removal of old industrial eyesores; but new industries failed to be enticed.

Accordingly, in 1936, the Special Areas Reconstruction Association was established to make capital available at attractive terms to entrepreneurs willing and ready to undertake business in the specified regions. In 1938 Lord Nuffield established the Nuffield Trust, an additional source of financial assistance to businessmen who would build in the designated zones. So strong was public interest and sympathy that the special areas were receiving *both* governmental and private aid.

In implementing this general attack on the problem, numerous techniques were utilized by the British. Although Professor Dennison has described many of these, the present discussion will allow but a scattered listing of some of the more important: Payment, in whole or in part by the Commissioner of the Special Areas, of such costs as rent and taxes for an entrepreneur entering upon business in the designated regions; factory units with all necessities, including light, engineering and market advice, at reduced rates for businesses looking for space in plants abandoned by their former owners and rehabilitated at government expense; loans at reduced interest to borrowers willing to undertake new enterprises in the special areas; reduction of overt unemployment in certain regions by aid through government finance; a back-to-the-farm movement for older men and their families; grants by Parliament to aid in rehabilitating the amenities of special regions; induced migration of labor from the special areas to more prosperous regions by means of grants for traveling, family and furniture removal, and job finding; provision of special worker training programs to educate, rehabilitate, and fit men for desirable employment in regions of industrial expansion.

In the designation of certain localities as special areas and in the admission that such problem spots need special treatment, Professor Dennison is in agreement with current British thought. He states the problem thus: "So long as the industrial system is subject to change, with the growth of new forms of activity to replace those which die away as demands and technique change, then we shall have the problem of the emergence of depressed areas."

The wise determination of such areas, however, is described as most difficult. Should the least depressed localities be aided first because they offer the best potentialities for development? Or should the most depressed have priority because their need is greater? Should unemployment figures alone serve as a criterion for selection or should some more comprehensive test be used?

The heart of Professor Dennison's argument, however, deals not with the descriptions and definitions of special areas and of the machinery for handling their problems but with the wisdom or error of shifting the control of such efforts from private to governmental hands. In this connection the author stresses that up to the present at least, the British efforts toward government control of industrial location have been highly experimental and surely no more than exploratory. If inducements financed by public expenditures are to be successful, for example, they must provide considerably larger benefits than heretofore. If intervention is to be given a real try, it must be wide in coverage, wholehearted in spirit, and above all, energetic and forceful.

To provide drive is difficult, however, when direction is absent, and it is stressed that direction and unity have been notoriously lacking. The Commissioner has never been given a well-defined aim toward which to work. For instance, no decision has been made as to whether the development of the depressed areas should take precedence over attempts at dispersion of urban concentrations such as London. Lack of clarity as to goals has constantly led to such anomalies as moving the best workers out of areas to which employees were later to be asked to come. Furthermore, although it has been suggested that industrial location brings social gains, it may also entail economic losses in terms of productive efficiency. It was urged that the gains would outweigh the losses but no very painstaking, persuasive appraisal of the entire process has been presented. Lacking this clear view of purpose, it is not surprising that as various governmental departments have been drawn in, occasionally the tail has, at least apparently, wagged the dog.

In conclusion, Professor Dennison stresses that, in his belief, the unemployment problem is an ephemeral phenomenon, whereas industrial location has far-reaching economic industrial repercussions. Accordingly, even at its best, governmental control of the British type is dubious for "... control, if it is perfectly exercised, involves the importation of a long-period remedy for short-period problems." But even if the problem is held to be long-run, is there good reason to suppose that unified control of its solution will be "perfectly exercised?" His argument is clearly put: "... if we can judge from the experience of intervention in other economic matters, such as in the various agricultural schemes, in the operation of the tariff system, or in the special assistance given to certain industries during the depression or, indeed, from policy with regard to the depressed areas, it is a mark of supreme optimism to expect that a policy will be in any way distinguished by thought for larger issues and long-period aims; it is possible for a system to be more planned against than planning. To subject location to control on the basis of empirical expediency, or to the play of various political motives, would be but a poor substitute for laissez-faire, however undesirable some of the effects of the latter may be."

The evaluation of such a book constitutes a very real challenge. The description we read of British problems and devices is workmanlike and full. The raising of difficult questions on matters of policy and practice is pertinent and thought-provoking. The philosophy is that of English liberalism kindled to its persuasive best by fears of centralized control. The argument is in its proper setting; each part is in its place. One latent contradiction, however, prevents the analysis of the problem from adding up to a constructive proposal for solution. For, at the conclusion of his eloquent description of the movement of a small fraction of idle labor and industry away from depressed areas and toward expanding localities like London, the author has been compelled in all candor to add that: "... there is little chance that the problem of the depressed areas will yield to spontaneous solutions."

If in contemporary affairs, the consistent, honest liberal is thus led to argue that centralized control of industrial location, as of other matters, is dangerous, whereas spontaneous solution is extremely unlikely, are we faced with another cryptic appeal to some as yet ambiguous third line of human conduct, or for those who still seek "full employment," is this but one more counsel of despair?

DENVER ENGINEERS SUPPORT THEIR PUBLIC LIBRARY

By MARGERY BEDINGER

CHIEF, SCIENCE AND ENGINEERING DEPARTMENT, DENVER PUBLIC LIBRARY

EVERY engineer knows that access to a good library is a necessity for him. Librarians realize this, too, and are striving to make their collections of practical usefulness to the working or the research engineer. Denver, one of the leading engineering centers of the country, has a unique library setup that works so well and is so practical in operation, it would seem other cities might be interested in it. This setup has been thoroughly tested eighteen years.

ENGINEERS DECIDE TO JOIN FORCES WITH PUBLIC LIBRARY

In 1922 a group of engineers, feeling the need of a technical library, proposed to organize one for themselves in a downtown building. Before this was done, however, Dr. H. W. Craver, director of the Engineering Societies Library in New York, was asked by a group of local engineering leaders and the city librarian to survey the situation in Denver and recommend a plan for a technical library. He suggested that the engineers join forces with the public library, and persuaded both parties that by pooling resources a really first-class collection could be gathered and administered. A little thought showed the engineers that by this scheme they would be saved rent, light, heat, and janitor service; and the money so saved could be used to buy technical publications. It was also pointed out that if the collection were part of the public library, professional librarians would administer it, which would be far more efficient than the typist-stenographer sort of aid which is all the engineers by themselves could afford. In addition to these savings, much costly and purposeless duplication of magazines, journals, society proceedings, and books would be prevented. Duplication of binding costs would also be eliminated. All these items are heavy and taken together amount to a pretty sum, a sum that could buy many books yearly.

It was decided to follow this idea and a definite plan of cooperation was worked out. This plan is in effect now. The result has grown into the largest technical library between Chicago and the Coast and one administered always for the practical use of engineers and technical men.

The outline of the plan is simple. The public library has created a separate Science and Engineering Department in its main library building conveniently situated in the downtown district. In addition to reader and stack space the public library also contributes all overhead costs, which include furniture, equipment and supplies, heat, light, janitor service, and repairs of all kinds. In addition, and this is most important, the books are catalogued and classified by the trained professional cataloguers on the library staff; they are administered by a professional librarian who has specialized for years in this type of library work, and the reference assistants (the girls at the desk, whom the public meet) are all professional librarians trained for this work. The city library also buys, prepares for binding (a rather technical job), and pays for binding a long list of scientific and engineering magazines and serial publications of various types which must form the backbone of any technical library. It also sets aside a sum each year from its budget to buy books for this department.

LICENSE REGISTRATION FEES USED TO BUY BOOKS

On their side, the engineers give money. This money comes from their license fees. Five dollars a year is charged by the State Board of Examiners for Engineers and Land Surveyors for every engineer licensed by them. After the small expenses of the Board are taken out, the remaining sum may be voted by the Board for the purchase of technical books and publications. The books so purchased are stamped "Property of the State Board of Examiners for Engineers and Land Surveyors Deposited in the Public Library of the City of Denver," and bear their bookplate. A symbol is also placed on the library records indicating this ownership. Except for these matters of routine, the books are treated like other volumes bought with library funds. They are shelved where they classify, circulate freely to card holders, and are mended and rebound at library expense.

The selecting of the titles to be bought with these funds is one of the duties of the head of the Science and Engineering Department of the public library. In this task, which is heavy and highly important, she asks advice freely of the engineers as will be explained later, and the men are urged to suggest titles. But the final decision rests with the public library. Its hands are purposely left free, as it is realized that if the library has the responsibility of administration, it must also have the power and freedom to do as it thinks best.

In return for this money, every licensed engineer may draw books, whether he is otherwise entitled to a card or not. A quarterly list of the books added to the library, whether by purchase from the engineers' fund, other funds, or gift, is sent to all registered engineers and members of the Colorado Scientific Society. The chief of the department edits a page in the monthly organ of the Colorado Society of Engineers, to which organization most of the engineers belong.

From the beginning, the engineers have taken a liberal view and have urged the purchase of books useful to students of all grades and to mechanics and technicians of all kinds. As the collection is a part of the public library and housed in its building, the entire community feels free to come to it. Thus the inhabitants of Denver, Colorado, and the neighboring states benefit tremendously by free access to this fine collection, which no city or institution in the region has the money to create and keep up by itself. The engineering profession gains directly from its use to members and also indirectly through help to students and technicians.

This in brief tells of the results of cooperative effort between the engineers of Colorado and The Denver Public Library.

COLORADO SCIENTIFIC SOCIETY JOINS THE PLAN

Another organization has joined in to form the library. This is the Colorado Scientific Society. It contributes in two ways. It donated at the inception a nucleus of scientific and engineering books which formed its own library, and it gives to the library its exchanges. These are publications of scientific societies and institutions all over the world, which the society receives in exchange for its own proceedings. These exchanges are stamped "Colorado Scientific Society," when bound, and

bear the society bookplate. A symbol indicating society ownership is put on the records. The library houses, binds, and administers these exactly as it does the publications it buys itself.

D. L. Brechner described in the November, 1940, issue of MECHANICAL ENGINEERING, page 800, how certain sets belonging to the U. S. Bureau of Reclamation are deposited in the Denver Public Library. In the same way, material belonging to the State Board of Examiners, to the Colorado Scientific Society, and to the Denver Public Library is all integrated to form one organized unit. Yet through the stamps, bookplates, and symbols on our card records, the property of each keeps its identity and at any time could be separated and withdrawn from the rest.

In brief, the Science and Engineering Department of The Denver Public Library is really three things: It is a department of the city library and it is the library for the Colorado Scientific Society and the Colorado Society of Engineers, the membership of which practically coincides with the engineers licensed by the State Board. These three titles appear on the door of the reading room.

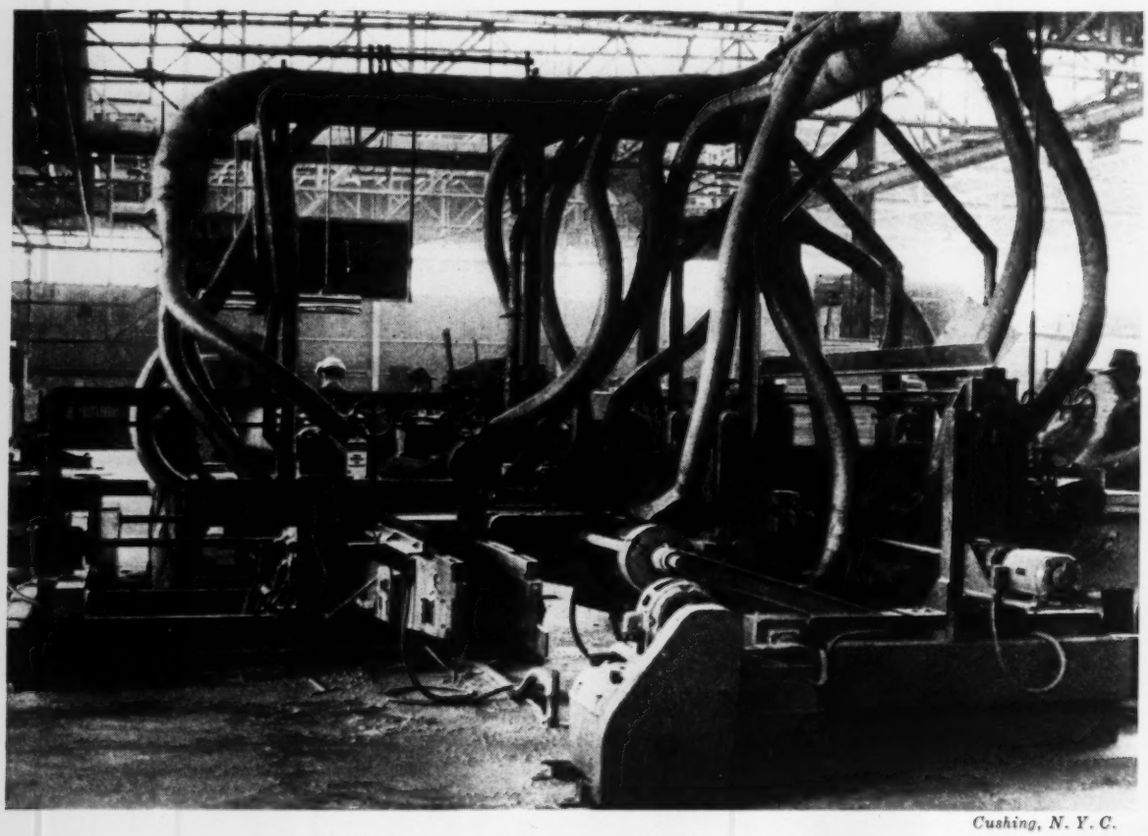
ENGINEERS' LIBRARY COMMITTEE ASSISTS LIBRARIAN

The Colorado Society of Engineers has a library committee which meets, usually for lunch, with their librarian when occasion demands. It is stressed that the purpose of this committee is to help the librarian. There is no thought of interference or dictation. It should be emphasized that the librarian is a department chief of the Denver Public Library and as such is a regular member of the staff, chosen by and amenable to the head librarian. She is paid by city funds. Her function as librarian of the Colorado Scientific Society and the Colorado Society of Engineers is merely coincidental with her other duties. In fact, the two societies have no control over the way their library is administered. In practice, however, they could withdraw their support at any time and take away their property. Naturally, her triple functions are always kept vividly in mind by the chief of the Science and Engineering Department.

To increase interest in the library among the engineers, as well as to aid the librarian, there is an adviser for every important subject. These advisers are outstanding in their particular fields and are connected with the larger industrial concerns, government bureaus, or institutions of higher learning in the state. In this way the library has a direct contact with the very groups it exists to serve and each of these different groups has a representative to look out for its library interests. These contacts are valuable to both parties. In addition, the advice of these men with their special technical knowledge is invaluable to the librarian in the acquisition of new material, discarding of out-dated and obsolete books, as well as bringing to her attention the obscure pamphlet or publications of firms and research laboratories that are not usually known.

These men serve when called on and their duties are not heavy, usually merely a telephone call. But all of them are asked to come in once and be shown what the library can offer them. This initial visit is always an eye opener, as few engineers realize the resources at their command. This personal visit is the best sort of publicity for the library. It also gives an opportunity to talk with keymen and find out what they want and how the service can be improved. The whole adviser arrangement is entirely informal and works smoothly and quietly without red tape, or undue consumption of time. The list is flexible and usually numbers about fifty.

The engineers of Denver are proud of their library setup and the library knows what a big contribution to the entire community the engineers are making through their unselfish and far-sighted sharing of their resources with the public.



Cushing, N. Y. C.

A SAW IN THE JARRATT, VA., PLANT OF THE JOHNS-MANVILLE CO.

BRIEFING THE RECORD

Abstracts and Comments Based on Current Periodicals and Events

MATERIAL for these pages is assembled from numerous sources and aims to cover a broad range of subject matter. While few quotation marks are used, passages that are directly quoted are obvious from the context and credit to original sources is given.

Better Automotive Fuels

S.A.E. JOURNAL

ADVANCES in petroleum chemistry and refining have been so rapid that engineers not directly concerned with these problems or with the application of the new fuels available and in use find themselves in need of a comprehensive review of the situation with respect to high-grade motor fuels as it stands today. Such a review will be found in a paper entitled "Better Fuels for Better Engines," by William H. Hubner, of the Refinery Technology Division, Ethyl Gasoline Corp., published in the *S.A.E. Journal*, October, 1940.

It is obvious, says Mr. Hubner, that the refiner has a rather difficult course to follow in producing satisfactory motor fuels. His raw materials and finished products are complex combinations, both chemically and physically. His products must be utilized by all types of engines under all sorts of conditions. In addition, the demand for gasoline is so tremendous that the refiner must produce on a mass-production basis. Fortunately, gasolines and engines can be placed in several broad groupings so that a comparatively few grades of fuel are required for generally satisfactory engine performance.

Gasoline is not a static product, as the continual improvement of engines, springing from research in engine design and advancement in fuel technology, has resulted in a steady advance in quality. This advancement is likely to continue along well-defined lines. Volatility apparently has reached a leveling-off point, although the trend is toward more volatile fuels. The trend in antiknock value is definitely upward. It is not unlikely that, by 1945, road octane values will reach a level of 95 for premium-grade and 85 to 90 for regular-grade fuels. An average of the Motor and Research methods offers a means for evaluating such levels in terms of present-day refinery practice.

[The terms Motor and Research refer to two standard methods of testing fuels. Motor refers to the A.S.T.M. method D-357-39, adopted as standard in 1939, although used as a tentative standard since 1933. Research refers to the C.F.R. research method (1939) developed by the Cooperative Fuel Research Committee primarily for research purposes. In general each method gives a different octane value for a given fuel, but there is no constant difference between them for all types of fuels. With few exceptions the Research method gives higher octane ratings.]

The increase will be gradual. The development of better engines and better fuels will go hand in hand as the result of closer cooperation between the automotive engineer and the refinery technologist. Sulphur content is becoming less important from the standpoint of corrosion, but still will be kept at a minimum by the cost factor in producing higher antiknock fuels. Low gum content and good storage stability still remain essential attributes of a good gasoline. The increasing use of cracked and polymerized materials may necessitate closer adherence to gum tolerances and possibly a re-evaluation of present gum-test methods. Regarding the trend in chemical composition, catalytic cracking and reforming appear to have heralded a new era in refining methods. The trend is definitely toward the use of catalysts, whether in cracking, reforming, polymerization, or alkylation operations, with good reasons to believe that present high cost will be reduced.

[The article explains the terms polymerization, "joining together two or more molecules to form a single molecule of higher boiling point;" catalytic cracking and reforming which "differ from the thermal cracking and reforming developed in the earlier days of the industry in that they utilize a catalyst, in addition to heat and pressure, to effect the conversion;" and alkylation, which "provides in one step a saturated type of product similar to that produced in two steps by a combination of polymerization and hydrogenation. Alkylation combines one molecule of an olefin with one molecule of a paraffin hydrocarbon."]

The fuel of the future may be a blend of catalytically cracked and reformed gasolines and alkylate, with tetraethyl lead or other antiknock compounds added to produce the desired octane level. The need for antiknock compounds may be strictly economic or it may be the means of maintaining uniform quality which is so necessary for satisfactory customer acceptance.

Military Airplanes

THE JOURNAL OF ENGINEERING EDUCATION

IN a portion of a paper entitled "New Obligations in Aeronautics," to be found in the October, 1940, issue of *The Journal of Engineering Education*, W. F. Durand, honorary member and past-president of The American Society of Mechanical Engineers, has the following to say about the military airplane. It can be said to:

1 Navigate the air under control, at speeds of, say, from 50 to 400 mph, at altitudes from sea level to, say, 30,000 ft; and, radio-directed, carry out missions to some extent independent of conditions affecting visibility through the atmosphere.

2 Carry effective loads up to several tons.

Resulting from this, airplanes can:

1 Carry, over enemy territory or territory held by the enemy, one or more observers with modern photographic equipment for obtaining information regarding:

- (*a*) Concentrations of enemy troops or movements of the same, with estimate of number, character, and equipment
- (*b*) Artillery spotting
- (*c*) Locations of enemy arsenals, concentrations of supplies, artillery positions, machine-gun nests, ammunition dumps, etc.
- (*d*) General mapping of enemy terrain.

These missions fall under the general head of what may be called the "service of information." Aircraft for carrying out such missions are called "scout" or "observation" planes.

2 Again, an airplane can carry military loads in the form of machine guns, heavier quick-firing guns, bombs, with operating

personnel. These bombs may weigh individually from 20 or 30 pounds to as much as 4000 pounds with destructive power in proportion.

3 Again, aircraft can transport personnel and munitions to be dropped by parachute, with what effect has been shown in the drive of Russia against Finland and of Germany against Norway and the low countries, Denmark, Holland, Belgium, as well as against France. No great numbers can be transported in this manner, that is, numbers when reckoned in comparison with regiments or divisions. But with the technique and strategy employed by the Russians and Germans in the use of these parachute troops, they seem to have demonstrated a definite field of effective service.

These more direct military capabilities of aircraft have given rise to major types somewhat as follows:

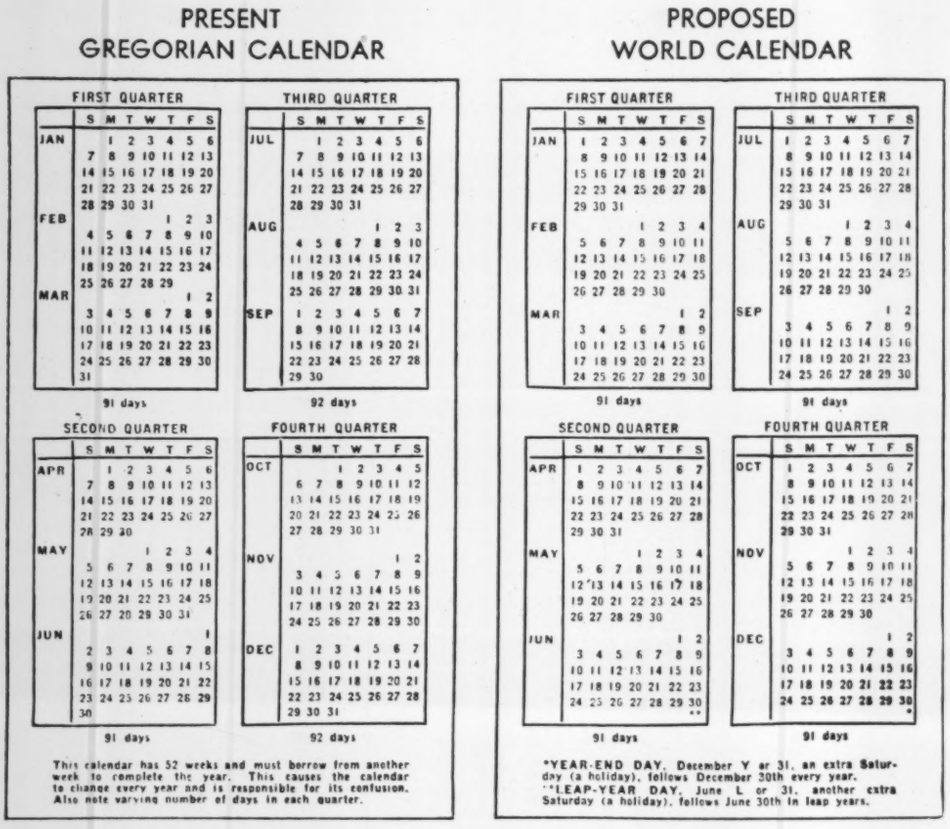
1 *Bombers*, carrying military loads in the form of bombs up to several tons in the aggregate. There are several subdivisions to this Class: Heavy bombers, large planes carrying the heaviest loads of large bombs; light bombers, smaller and perhaps faster planes carrying lighter loads of smaller bombs, with intermediate gradations as to size and load; dive bombers, intended especially to loose their load of bombs at or near the bottom of a fast power dive. Again, bombs themselves are variously subdivided into demolition bombs: Heavy weight and heavy charge of explosive for the maximum destructive shattering effect; fragmentation bombs with the shell made of relatively brittle material and moderate bursting charge, intended to produce a large number of small flying metal fragments; incendiary bombs with a charge of fierce combustible intended to start fires; and gas bombs, with purpose as indicated by the name.

It may be of interest to note here that the limit velocity of an airplane bomb is somewhere between 800 and 900 fps. To attain such a velocity in free fall, the bomb must be released from a high altitude—20,000 ft or higher. But even so, the bomb must be considered relatively inefficient as an armor-piercing agency compared with a shell from a high-power coast-defense or naval gun. With these latter, the striking velocity may well be twice these figures with an energy per pound four times as great as for the bomb. Again, if a bomber goes to these high altitudes for release of its bombs, close target practice becomes hopeless. If on the other hand the bomber releases its bombs at a low altitude, the target practice becomes much better, but the striking velocity is reduced due to the shorter distance and time of fall. If released near the bottom of a power dive, there will be at the start, a component velocity of the bomb derived from the plane, which, combined with gravity, may give it a striking velocity equal to or possibly exceeding that due to free fall from a much greater height. However, all told, the airplane bomb is relatively ineffective as an armor-piercing projectile. Against ordinary building construction, its destructive capacities are almost unlimited, as shown by the results of the bombing in Poland, Finland, and more recently in Western Europe.

2 Next in the category of military planes we have the "fighter" or "pursuit" plane, carrying one or more machine guns, perhaps heavier quick-firing guns manned by one or more pilots or gunners. These planes have the highest speed attainable, in combination with other needful features, and are intended for the protection of bombers or observation planes of the home forces, or for offensive operations against enemy aircraft of all types. There are special types of these fighting planes such as the "interceptor," with especially fast climb, intended to meet, intercept, and fight enemy bombers or other enemy aircraft; or again "attack" planes carrying light bombs, several machine or heavier guns, and intended especially for operations against troops on the ground.

3 And then, mention should be made of transport planes intended for the carrying of troops or munitions, with objectives referred to earlier and so well demonstrated in the present European war.

Thus far, the view has been


PRESENT
GREGORIAN CALENDAR
FIRST QUARTER
THIRD QUARTER
SECOND QUARTER
FOURTH QUARTER
91 days
92 days
This calendar has 52 weeks and must borrow from another week to complete the year. This causes the calendar to change every year and is responsible for its confusion. Also note varying number of days in each quarter.
PROPOSED
WORLD CALENDAR
FIRST QUARTER
THIRD QUARTER
SECOND QUARTER
FOURTH QUARTER
91 days
91 days
*YEAR-END DAY. December Y or 31, an extra Saturday (a holiday), follows December 30th every year.
**LEAP-YEAR DAY. June L or 31, another extra Saturday (a holiday), follows June 30th in leap years.

PRESENT GREGORIAN 1940 CALENDAR AND PROPOSED WORLD CALENDAR

(Exhibited in the New York Museum of Science and Industry is a proposed new calendar which rearranges the length of the familiar 12 months, equalizes the quarters and half years, and makes the calendar perpetual, every year being the same. Equalization of the quarters and half years is accomplished by giving the first month of every quarter 31 days and each of the remaining two months 30 days. Thus the 12-month year has four months of 31 days each and eight months of 30 days each. Every month has exactly 26 weekdays in addition to Sundays; every quarter begins on Sunday and ends with Saturday; and every year begins with Sunday, January 1. According to the descriptive material accompanying the New York exhibit fourteen nations have already indicated their willingness to accept the new calendar.)

from the side of *offensive* warfare.

Brief note may be taken of the situation from the side of defense:

First, for defense against scout or observation planes, there is the pursuit or fighter, and the antiaircraft gun.

Then against the bomber, defensive measures comprise the pursuit, fighter, or interceptor plane; antiaircraft guns; detection by searchlight or acoustic methods; captive balloons with wire entanglements; camouflage; blacking-out; and offense against enemy bases.

Against planes of the fighter, pursuit, or attack type, the only defense is by way of planes of the same general category —or a gain by antiaircraft guns.

Transport planes with parachute troops will normally be accompanied and defended by fighters or light bombers and the defense against this combination must, therefore, be planes of the same fighting types.

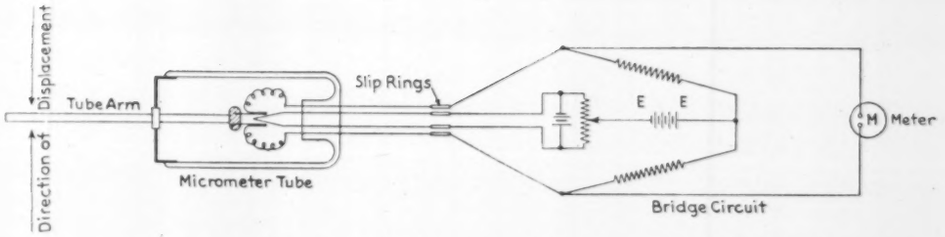


FIG. 1 SCHEMATIC DIAGRAM OF THE ELECTRICAL MICROMETER TUBE CIRCUIT

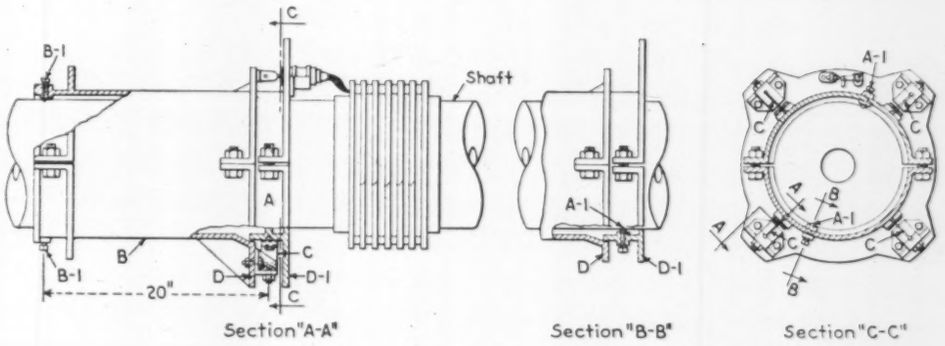


FIG. 2 REVOLVING PORTION OF POWER-TORQUE METER

Power-Torque Meter

THE SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS

AN application of the electrical micrometer, described by Ross Gunn in the *Journal of Applied Mechanics* for June, 1940, to the angular displacement caused by the torque in a shaft has been made at the Naval Research Laboratory, Anacostia Station, Washington, D. C., resulting in a new type of power-torque meter which permits the power transmitted by the shaft to be measured directly, according to Wayne C. Hall, in a paper delivered at the annual meeting, Nov. 14 and 15, 1940, of The Society of Naval Architects and Marine Engineers.

The electrical micrometer tube consists of a vacuum tube with a hot cathode which is surrounded by a space charge of electrons, and two insulated plates, or anodes, to which electrical connections can be made from outside the tube. These plates are both mounted on a movable arm whose position relative to the hot cathode is adjustable from outside the tube. Normally, the two plates are on either side of the hot cathode, equidistant therefrom; but any proper movement of the arm outside the tube results in displacing one plate toward the hot cathode and the other away from it, and by equal amounts. It can be seen by reference to Fig. 1 that there is a variable plate resistance in the tube between each plate and the hot cathode. Moreover, the resistances may be varied simultaneously in opposite directions by any small mechanical displacement of the tube arm. Measurement of the resulting change in resistance can most conveniently be done in a Wheatstone-bridge network where the two variable plate resistances make up two adjacent branches of the bridge, and two equal fixed resistances, of a magnitude which approximately equals that of the plate resistances, make up the other two branches of the bridge. Then, when an appropriate source of constant voltage is applied across the bridge, the state of balance may be indicated by a current meter across the bridge diagonal.

In Fig. 2 are shown sections of the revolving portion of one experimental model of the power-torque meter. The design is an adaptation of the usual type of short-base-length torsionmeter. This part of the apparatus consists of two cylindrical castings, a short one *A* and a longer one *B*, clamped to the shaft at *A*-1 and *B*-1, respectively. The free end of the casting *B* is supported on and kept concentric with *A* by means of the flexible tension members *C* which are constructed of thin steel plates that offer no appreciable obstruction to rotational movements between the castings *A* and *B*. The angle of twist between the planes *A*-1 and *B*-1 caused by the twisting of the shaft under torque is, therefore, transmitted to the flanges *D* and *D*-1 and causes them to be displaced relatively to each other by the same amount. In consequence, the electrical micrometer tube arm is moved relatively to the tube by the twisting of the shaft. With such an arrangement any twisting of the shaft unbalances the bridge by a proportionate amount. But, when the shaft is not under load, the bridge will be balanced and the pointer of the current meter which is across the bridge circuit will be at the zero position, thus indicating the absence of torque in the shaft.

In the measurement of power used in the instrument described, the same meter which was used to indicate torque also was used to indicate the shaft power. The method makes use of a property of the electrical micrometer tube in that the sensitivity of the tube, that is, the meter reading for a given displacement of the tube arm within certain limits, is exactly proportional to the voltage which is applied to the bridge at *E-E*. Hence, by use of a shaft-driven tachometer generator which will supply a voltage that is proportional to shaft speed to the bridge, the current meter will indicate a quantity that bears a direct ratio to the shaft power. In other words, direct power measurements can be expanded by a ratio of 20 to 1 through the use of the range switch on the current meter, just as for torque measurements.

That there are some minor difficulties is shown by the curve of Fig. 3 which includes the results of one test run. The shaft power measurements which were determined directly by the meter deviate by some 3 per cent at high speeds from the calculated shaft powers. It has been found that this difficulty

is connected with a lack of symmetry in the tube structure and bridge circuit, which causes deviations of the electrical-circuit characteristics of the tube.

It is to be emphasized that the power-torque meter which

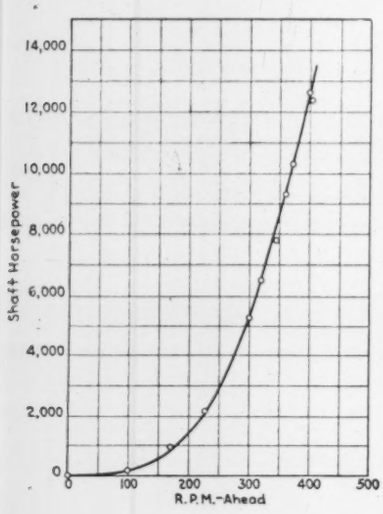


FIG. 3 COMPARISON OF MEASUREMENTS OF CALIBRATED POWER METER (INDICATED BY CIRCLES) WITH THE AVERAGE POWER CALCULATED FROM TORQUE AND SPEED MEASUREMENTS (INDICATED BY SOLID LINE)

was developed and tested to indicate either shaft torque or shaft power directly was an experimental model. At the conclusion of the tests certain difficulties still remained, but these can be corrected.

Control for Bessemers

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS

RENEWED interest in the Bessemer process of steelmaking was indicated by H. W. Graham, director of metallurgy and research of the Jones and Laughlin Steel Corporation, Pittsburgh, Pa., at a meeting of the Iron and Steel Division of the American Institute of Mining and Metallurgical Engineers, at the National Metal Congress, Cleveland, Ohio, Oct. 21, 1940.

Appraising broadly the technical knowledge and methods of producing Bessemer steel, Mr. Graham pointed out that, granted the necessary assistance by management and operating staff, the only factor limiting the extent of such a revival is the rapidity and completeness with which metallurgists can solve such quality problems as are involved.

Attention was focused on this paper by the fact that patents were recently granted on a method for controlling the Bessemer blow by an arrangement of photoelectric cells and other instruments which eliminate the human element in determining the end point of the blow. This invention is the result of intensive research and development work directed by Mr. Graham.

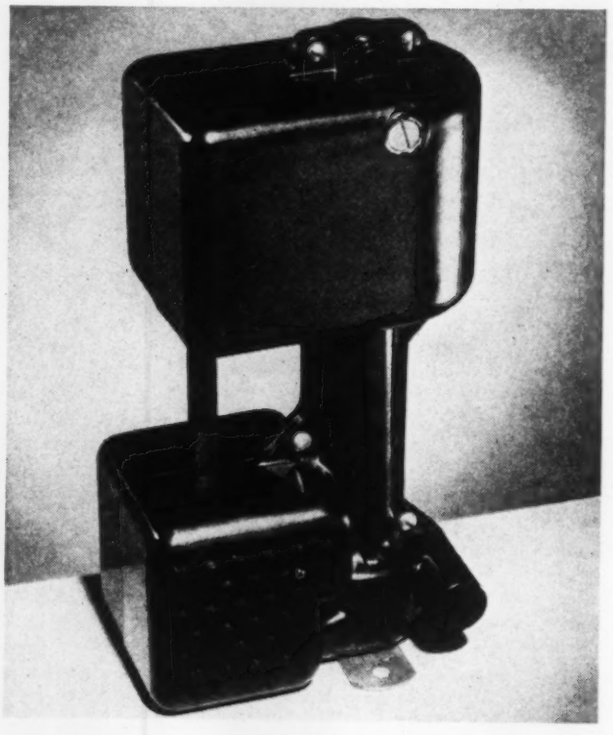
Possibilities were outlined by Mr. Graham for increasing steel production by making greater use of the existing Bessemer steelmaking facilities, and, at the same time, conserving the strategic supply of scrap in the present rush of turning out steel for defense needs. In this connection Mr. Graham said that the Bessemer process was more than self-sufficient on scrap and produced scrap as a by-product. The open-hearth method, he said, constantly used more scrap than it produced and this deficit had to be supplied by trade scrap originating from previously manufactured steel articles.

Throughout its history, Bessemer steel, Mr. Graham stated, has had certain inherent qualities which make it preferable to open-hearth steel for certain specific applications. If the Bessemer process were given even a portion of the lavish technical aid provided for the open-hearth process, it might retain its proportionate place, retaining its undoubted inherent advantages, Mr. Graham said. The problem facing the Bessemer steel metallurgist today is not to remove the inherent qualities of Bessemer steel, he asserted, but to identify them and derive controls therefore so that they can be reproducibly placed at will at any given desired value.

Mr. Graham discussed the many factors affecting control of the Bessemer process, and developed the fundamental considerations involved in the control of iron temperature and quality, of air-blast volume, and moisture content, and further dealt with the extent to which mechanical features affected such control.

The determination of the finishing time or "end point" of the blow is of great importance, Mr. Graham said, because, although the Bessemer process is essentially automatic in character and will proceed satisfactorily, the end point is not automatic. In fact, he said, at a given moment the charge begins to "commit suicide," so to speak, by burning itself back into iron oxide. This change takes place with great rapidity and therefore precise control of the end point becomes a matter of greatest importance.

A few years ago, he said, it was proposed that the luminous energy of the flame as measured by a photocell arrangement



A BILGE PUMP WITH MOLDED PLASTIC CASING, SCREEN, PIPING, AND IMPELLER

(This electric bilge pump, molded of a phenolic plastic, is resistant to the onslaughts of salt water, electrolytic action, and corrosion. It won top prize in the transport group of the Fifth Annual Modern Plastics Competition, according to an article in *Modern Plastics* for October, 1940. The phenolic case is molded with such accuracy that no machining operations are necessary. Even though it only takes up a floor space of $5\frac{1}{2} \times 3\frac{1}{2}$ in. and is 10 in. high, the unit will handle 70 gal of water per amp-hr of battery power used.)

might be a basis for control. Subsequent development work by the research and plant metallurgical staffs had produced a method that has helpful control features. The flame is viewed by a suitable photocell and amplifier arrangement, and a continuous graphic record is obtained of the energy registered.

With this system in operation it was possible to check the blower's visual estimations against an instantaneous instrumentally obtained record. It followed that it was possible to get, devoid of human equation, an evaluation of the time factor at the end of the blow.

As a result of many tests, Mr. Graham claimed that the end point of the flame has a direct bearing on quality results, showing that the yield of good material was highest when the blow was stopped at the proper time and that by varying the time of the "afterblow" a matter of a few seconds, desired quality results can be predetermined at will. The efforts of his research and metallurgical staffs are now being directed to full exploration of the exact length of afterblow which is most favorable for each grade of product, he said.

Turning from his discussion of the determination of the end point and the mechanical and operating features of the process, Mr. Graham concluded with a discussion of the more purely metallurgical phases of the Bessemer blow, pointing out how methods for control of these phases are rapidly being developed on a basis that promises to bring the Bessemer process up to the quality level of other steelmaking methods.

Mercury Cargo Ship

THE AMERICAN SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS

A PROPOSED application of the mercury-vapor process to the propulsion of a cargo ship was discussed by W. Le R. Emmet, Fellow A.S.M.E., at the 1940 annual meeting, New York, N. Y., Nov. 14 and 15, of The Society of Naval Architects and Marine Engineers. In a paper presented at this meeting Mr. Emmet said that since the proposal, several years ago, of a marine mercury installation by the Sun Shipbuilding and Dry Dock Company in cooperation with the General Electric Company, a mercury boiler suitable to ships had been developed. A cross section of the boiler is shown in Fig. 4.

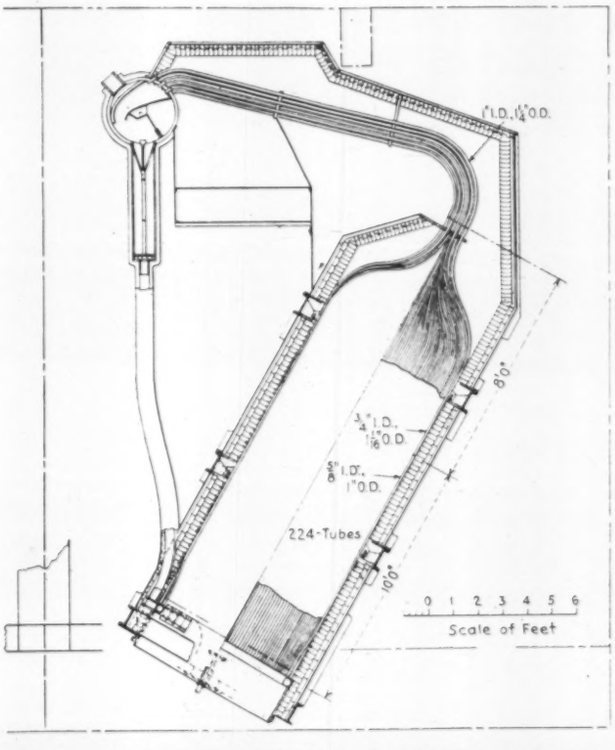
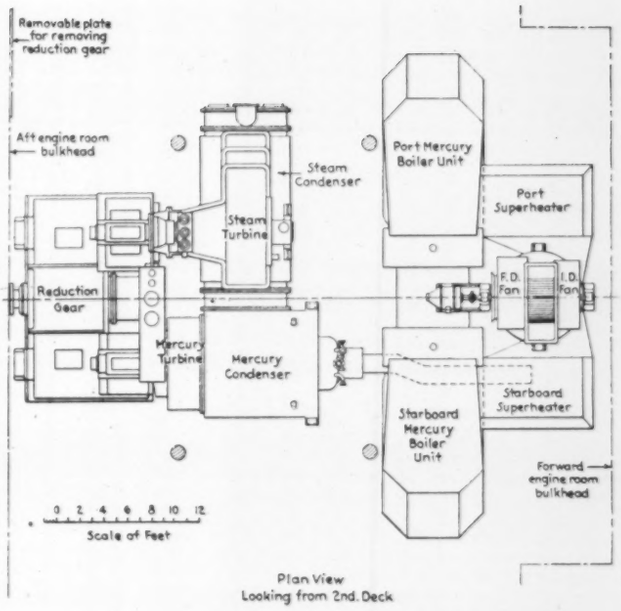


FIG. 4 MERCURY BOILER FOR MERCURY-PROPELLED CARGO SHIP



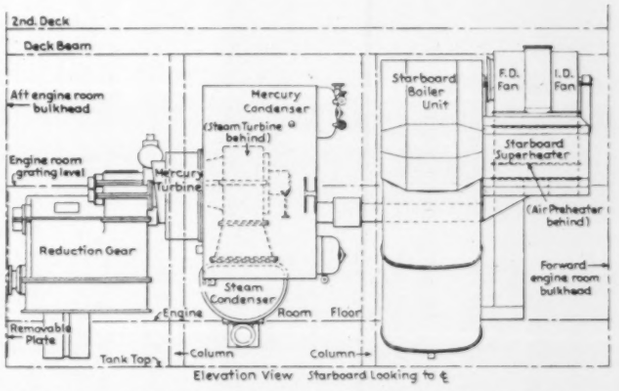


FIG. 5 THE MACHINERY ARRANGEMENT OF MERCURY-PROPELLED CARGO SHIP

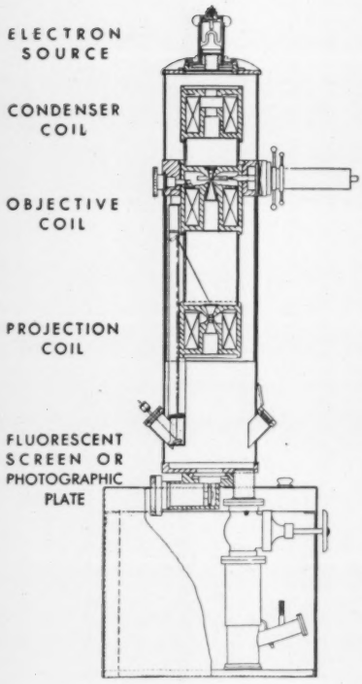
Mr. Emmet claims that the peculiar fitness of the mercury process for ship use lies largely in the extreme simplicity of the making of steam by the condensation of mercury vapor. According to Mr. Emmet, steam will do approximately half the work in a mercury-driven ship, and in the steam-making mercury condenser much of the complication and expense of the marine boiler are eliminated. The mercury turbine, being of much lower speed, is inherently a more efficient device than a steam turbine of equivalent capacity and complication.

The proposal worked out in Mr. Emmet's paper refers to a 9000-ton cargo vessel of the C-3 type adopted by the United States Maritime Commission. The normal shaft horsepower of this vessel is 8700 and the maximum demand 9350 shp. The speed of the single propeller is 85 rpm. Mr. Emmet proposes to deliver power to the propeller by two turbines, one driven by mercury vapor and the other by steam. The machinery arrangement is indicated in Fig. 5. Both turbines deliver power by double reduction through the same large gear on the propeller shaft. The mercury turbine will operate at about

1200 rpm and the steam at about 4000 rpm. Since the steam for all auxiliary and ship service purposes is normally made from heat delivered by the condensation of the mercury-turbine exhaust, the division of work between the turbines will depend on the quantity of such for other-purpose steam. With such steam use as is frequently required for heating, lighting, and power purposes in ships, the work delivered to the propeller by the two driving turbines will be not far from equal. Reversing will be accomplished as usual by elements in the low-pressure end of the steam turbine.

In addition to the sketches of the mercury boiler and the machinery arrangement, Mr. Emmet provides sketches of the mercury condenser and of the two turbines.

A table of calculated data, which includes a heat balance, is a feature of the paper. The calculations show, on the assumptions made, a fuel rate for all purposes of 0.443 lb of oil per shaft-horsepower-hour. While cost estimates have been made on the boilers, condensers, mercury and steam turbines, superheaters, air heaters, and the like for the case Mr. Emmet presents, he says that the best comparative idea of costs can be had by comparing weights, there being no reason for any wide variation in cost per pound of the comparable parts used in the proposed installation and in a steamer with geared turbines. These weights are given as 484,000 lb for the mercury equipment and 502,000 lb for the steam-turbine equipment. He adds that he has been informed by a shipbuilder who has built C-3 steamers that the difference of cost to them incident to the smaller steam condensers and engine rooms, auxiliaries plus the reduction in stack and fuel-handling facilities would amount to $56,000. This would more than pay for the mercury needed, which at normal prices would cost about $30,000.



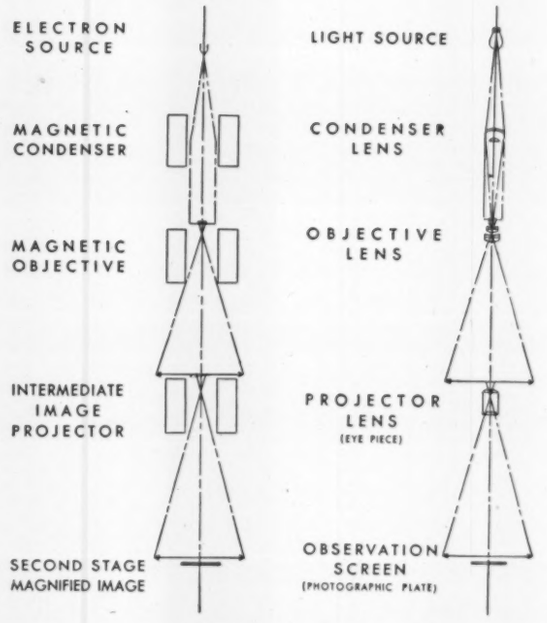


FIG. 6 SCHEMATIC SKETCH OF MICROSCOPE AND RAY PATHS

RCA Electron Microscope

ELECTRICAL ENGINEERING

IN February, 1937, a brief description was offered (p. 113) of a metallographic microscope that gave excellent definition at 5000 diameters and had an ultimate limit of 7000 diameters. In *Electrical Engineering* for November, 1940, V. K. Zworykin describes the recently developed RCA electron microscope which is capable of a magnification of about 25,000 diameters. If the image is recorded on a photographic plate, further enlargement photographically up to 100,000 diameters is possible. A schematic sketch of the microscope and ray paths is shown in Fig. 6.

A comparison of the schematic drawings of ray paths in the electron microscope and in a light microscope shows that the operation of the two instruments is essentially similar. The differences are dictated primarily by the differences in the properties of electrons and of light. Electrons leaving the source, a hot tungsten filament, are accelerated to their top speed by the strong electric field between the filament (at a negative potential of 30 to 100 kv) and the anode (at ground potential) placed directly below it. The electron beam issuing from a fine hole in the anode is concentrated on the object by a magnetic condenser lens. Electrons passing through the object and an aperture in the magnetic objective are focused by the latter into an image of the object magnified approximately 100 times and situated just above the magnetic projector lens. This last lens selects a portion of the intermediate image and enlarges it by a factor of approximately 250, yielding a final image projected on an interchangeable fluorescent screen or photographic plate with a magnification of about 25,000. Each of the three lenses consists of a coil of magnet wire enclosed in a soft-iron shield so shaped as to concentrate the magnetic field on a short section of the axis of the microscope.

The final image can be observed on the fluorescent screen through vacuum-tight windows in the side of the microscope. A simple periscope arrangement permits the observation of the less highly magnified intermediate image at the same eye level, facilitating the selection of the portion of the object to be further magnified. In order to make possible the rapid exchange of objects and photographic plates in spite of the high vacuum existing in the microscope, air locks are provided, similar to the escape chambers of a submarine. For example, when the object has been shifted by an external manipulation to its escape chamber, the latter can be closed off from the rest of the microscope, air can be admitted, and the object exchanged. After the chamber has been pumped out once more, the specimen can be reintroduced into the microscope—an operation that altogether takes only a little more than a minute.

The objects to be examined are deposited on nitrocellulose foils less than 1/1,000,000 of an inch thick. They may be cultures of bacteria, virus filtrated, colloidal suspensions, dusts or smokes, or materials of yet other character.

The electron microscope has, at the present time, a resolution capability at least 20 times better than the theoretical limit of the ordinary microscope—that is, it can separate objects less than 1/50 or a wave length of visible light or 1/300,000 inch apart. Certain fundamental defects of electron lenses, which

it has not proved possible to overcome with the means and knowledge now at hand, have so far prevented greatly exceeding this resolution. However, active research in this direction is being carried on and there is every reason to believe that it will lead, in the due course of events, to instruments of yet greater power and usefulness.

High-Temperature Alloy

AMERICAN SOCIETY FOR METALS

A NEW alloy may make it possible to extend further the temperature at which steam turbines are operated, without involving the expensive steels which seemed necessary before the new alloy was produced. E. R. Parker of the General Electric Research Laboratory at Schenectady first announced the new alloy, which is not a steel, at the annual meeting of the American Society for Metals, in Cleveland, Oct. 21, 1940.

Columbium, a relatively unfamiliar element and with a minimum of commercial importance at present, produces an alloy of exceptional properties when added in small amounts to iron. Samples containing three per cent of columbium and the remainder of iron reveal exceptionally good rupture strength at 1100 F, a temperature not yet commercially used but being approached by modern high-temperature, high-pressure steam turbines. No carbon is contained in the alloy, so it is not a steel; instead, the iron contains the columbium as a finely dispersed stable compound of iron and columbium, Mr. Parker reported.

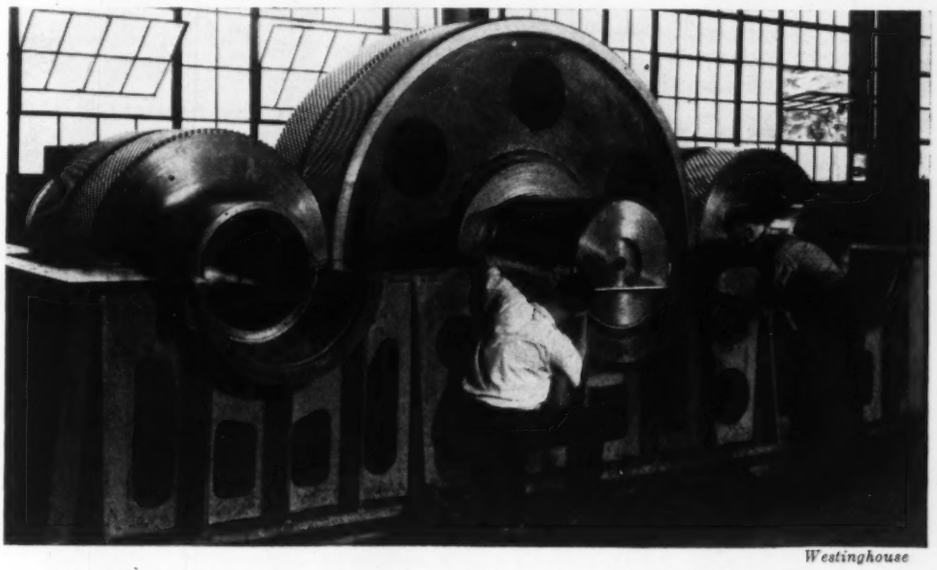
Special steels are readily available to answer the demands of turbines operating at today's highest temperatures—about 1000 F—temperatures sufficiently high to cause the metals to glow. Laboratory investigations have shown, however, that to continue with similar steels—with high contents of molybdenum, tungsten, vanadium, or such metals—would mean costly steels for turbines capable of successful operation at 1100 F or more. Metals flow or creep when subjected to stresses at high temperatures—by amounts so minute that their measurement might seem hardly possible and hardly of significance, but by amounts that are of great importance when considered over the period of years a turbine remains continuously in service and when considered in relation to the precise measurements that turbine efficiencies demand. Mr. Parker investigated alloys and steels of known compositions, and continued with new ones. The columbium-iron alloy he found outstanding of all at the specified temperature, considering its cost, ease of production, machinability, and other properties.

The alloys used by Mr. Parker for testing were melted in an induction furnace. Room-temperature tensile tests, creep tests, and rupture tests were conducted in accordance with the approved A.S.T.M. and similar standards. The creep furnace used is somewhat like the many large ones which have been used by the General Electric Company more than 15 years in its creep investigations. The high-temperature rupture furnace is so designed that tests can be made in any atmosphere, it being possible to have each sample in a different atmosphere, should such be desirable.

Mr. Parker's investigations indicate that, at temperatures of 1100 F and above, the strongest metals are not the carbide steels so successfully employed for somewhat lower temperatures but, rather, alloys containing a finely dispersed stable phase, such as the iron-columbium compound in the columbium alloy.

Mr. Parker has produced the columbium-iron alloy in different ways. He has mixed the correct proportions of the powdered metals, sintered them, and swaged the fused mass into a metal capable of being heat-treated and machined in the usual way. He has also cast and forged the alloy. His investigations have shown the cast alloy to equal the sintered material in its properties, so that commercial production of the alloy is not expected to offer difficulties.

Columbium, an element of steel-gray color and having a bright metallic luster, was discovered in 1801. By itself the metal is malleable and ductile, and very resistant to corrosion. At one time it was used in lamp filaments, and it is used in jewelry. There is also a columbium-stabilized 18-8 (stainless) steel in which the columbium forms a carbide. The element does not occur in the free state, and its minerals are relatively rare. Only a small tonnage of columbium is produced annually, but with increased demand the supply could easily be increased. At present most of the commercial supply comes from Australia. However, it was in ore of American origin—and hence columbium—that the element was first discovered.



Westinghouse

TWIN-ENGINE PROPULSION GEAR FOR A DIESEL-DRIVEN TYPE C-3 MARITIME COMMISSION VESSEL

(Each of its two pinions will be driven by a 4250-hp Diesel engine through an electric coupling, furnishing 8500 hp at 85 rpm to the propeller.)

COMMENTS ON PAPERS

Including Letters From Readers on Miscellaneous Subjects

A Study of Heat-Insulation Problems in Steam Power Plants

COMMENT BY R. M. BOWMAN[1]

The first point mentioned in the paper[2] namely, labor cost, is one of increasing importance and can materially influence the type of construction to be selected. Frequently an increase in the cost of a manufactured product is more than offset by the decrease in the construction labor cost.

The authors stress the matter of permanence and appearance, both of which are desirable considerations. So far as melting furnaces in steel plants are concerned, the life of a structure is relatively short when compared with a boiler furnace in a modern power plant, and maintenance work is quite routine. Brickwork is none too good in appearance, but nevertheless of the best quality and substantial in construction. The application of insulating cement to such furnaces is usually accomplished with a spray gun, although in some cases it is troweled on. Usually a new furnace is operated for 10 days or 2 weeks before insulation is applied to the walls, thereby allowing the brickwork, structural work, etc., to become fully adjusted to operating-temperature conditions. The insulating cement is made of such consistency that it can be readily applied, and by working on a sufficiently large area it is possible to build up the desired thickness in a few hours. Cracks sometimes develop after a shutdown, but these are easily closed with the spray gun and an efficient heat insulator as well as air seal is provided. Although the appearance of the completed work does not conform to the rigid requirements of central-power-station construction, nevertheless, in view of the short life of the furnace, additional expense is not justifiable.

Referring to some of the installations which the authors have discussed in detail, for example, ducts and breechings, the writer very much prefers to apply insulation rigidly to the interior rather than to the exterior of the structure, since by so doing, the structure itself, being insulated, is not subjected to the wide variations in temperature and in consequence the amount of expansion is materially reduced. While the initial cost of this type of insulation is high, it is quite permanent and maintenance costs are not excessive.

Concerning the practice of using standard flat-block covering for pipes larger than 10-in. diam., it would seem possible to anticipate repair and renewal work sufficiently in advance to obtain delivery of a covering meeting exactly the specifications for the particular work under consideration. The cost of flat blocks, together with the necessary cement, is substantially equal to the cost of curved segments, and the cost of applying the former is surely greater.

The experience cited relative to curly-glass-wool expansion joints is quite interesting and raises the question in the writer's mind: "Would not the double-layer covering have been satisfactory if sufficient clearance had been provided around the pipe with the inside and outside layers cemented or stapled together?"

Underground steam piping is nearly always a source of trouble and fundamentally it is wrong to omit or break the waterproof membrane surrounding the insulation. There seems to be no reason why a pipe covering cannot be developed for use at support rollers only, perhaps of slightly lower insulating value than is desired, but of sufficient strength to sustain the weight of the pipe in a saddle which partially surrounds the insulation. The writer has no doubt that manufacturers of insulating products will give this matter serious consideration and offer a satisfactory solution.

COMMENT BY E. R. CROFTS[3]

The problem of heat insulation in power plants and for underground steam mains is one which merits considerable study and the authors of this paper deserve to be commended for their broad consideration of all phases of insulation requirements pertinent to power plants and central heating.

It might be well to consider seriously the use of a unit type of underground construction whereby the steam company may purchase from the manufacturer a completely assembled unit of a predetermined length, consisting of a waterproof, rustproof, self-supporting conduit, containing the insulated pipe ready for installation underground. To date there are two such units available and are being produced and marketed by two reputable manufacturers. It is the opinion of the writer that the prefabricated unit today presents the most practical and economical solution of the problem of underground insulation.

As to high-temperature insulation for larger-size mains in the power plants, it appears that the use of curly glass wool at various points along the insulation should prove generally advantageous, and will eliminate the use of block or segmental insulation and permit the use of larger-size molded insulation, resulting in a more finished and economical installation.

The remainder of the paper contains very interesting application features and should be of material value to all industry.

COMMENT BY HANS DAHLSTRAND[4]

It is obvious that this subject is of great importance to power-plant engineers and that much improvement is required to present design and application of insulation materials. Further detailed study of this important subject seems highly desirable and it is hoped that ultimately we will have more complete information on proper insulation methods.

COMMENT BY H. W. GREIDER[5]

The emphasis which the authors have placed on the necessity for developing

[1] Purchasing Department, Republic Steel Corporation, Cleveland, Ohio.

[2] "A Study of Heat-Insulation Problems in Steam Power Plants," by E. T. Cope and W. F. Kinney, MECHANICAL ENGINEERING, June, 1940, pp. 465–470.

[3] Superintendent, Electric Department, Rochester Gas and Electric Corporation, Rochester, N. Y.

[4] Engineer-in-Charge, Steam Turbine Department, Allis-Chalmers Manufacturing Company, Milwaukee, Wis. Mem. A.S.M.E.

[5] Director of Research, The Philip Carey Manufacturing Company, Lockland, Ohio.

improved methods of installation which will reduce labor cost and insure better performance of the insulation seems fully justified. A few points in the paper suggest specific comment, as follows:

Furnace Walls. In water-tube-furnace walls, the cracking of insulation and the resulting infiltration of air can be very much reduced if not entirely overcome by following the practice adopted by one of the large boiler companies. It consists of applying a first coat of high-temperature, mineral-wool-type insulating cement in between and over the tubes to form a level surface projecting from $^1/_2$ to 1 in. beyond the outer line of the tubes. This is followed by the desired thickness of insulating blocks. A suitable grade of this cement has tough, somewhat "leathery" characteristics, and very high cohesion and adhesion, resulting in a minimum of spalling, powdering, and cracking. These characteristics are particularly noticeable in the cement made with the gray-brown (iron-silicate) type of blown mineral fiber. It is well to give consideration to the characteristics as called for in U. S. Navy Specification 32C14 when selecting cement for this purpose.

Ducts and Fan Housings. The experiences cited by The Detroit Edison Company are quite common. A method for eliminating cracking of insulation on ducts and fan housings has been in use for several years with demonstrable success. Without attempting a detailed description, it is based essentially on the principle of allowing free expansion of the metal duct without mechanical strain on the insulating material. In any system, wherein the insulating material is closely associated with the metal of the duct, cracking is almost certain to result.

Piping. Granting that the application of single-layer sectional pipe covering for pipe sizes up to and including 10 in. will involve somewhat less cost than the use of double-layer broken-joint covering, and granting that the heat loss at the joints of single-layer covering is not found to be excessive or objectionable when the coverings are properly installed with tight butt joints, the fact remains that pipe-covering mechanics of varying degrees of ability and responsibility apply these materials. Experience has proved that it is a much safer and better practice to use double-layer broken-joint construction.

The desirability of using narrow flat blocks for covering large-size piping is considered questionable. There would seem to be a lack of stability in such construction under the strains of vibration and of expansion and contraction which exist in high-temperature piping. Curved blocks to fit the pipes accurately give a much more substantial structure to the insulation and, if these curved blocks are drawn up tight with suitable bands, such as the Signode type, instead of the wire loops so often used, the result is a strong, firm, mechanical structure built on the principle of the arch, as in the case of a barrel- or wood-stave tank. For this condition, the real secret of obtaining the best results lies in the tightly drawn Signode strap banding.

The method described in the paper for providing expansion joints for high-temperature-pipe insulation is interesting and will bear further careful investigation. The adoption and further development of such a method may bring about a very definite improvement in insulation practice.

Underground Steam-Distribution Piping. Because no practical system has yet been developed which can be relied upon to keep underground pipe insulation dry, it would seem that the Boston Electric Illuminating Company and the United States Veterans Bureau have probably hit upon the best solution so far in the matter of insuring the stability of the insulation, even though it does become wet. This involves the use of wire-inserted asbestos-cloth jackets on the pipe covering instead of roofing jackets. If the pipe becomes submerged in water, steam forms around the pipe and is allowed to escape through the covering and the jacket with a minimum of hindrance or of destruction to the covering.

A decided improvement has recently been made in a laminated type of asbestos insulation for these underground pipes. Samples installed on test steam pipe, submerged in water and allowed to boil continuously for as long as 78 hr have shown no appreciable decomposition or change in structure, such as generally is indicated by a sagging tendency. The results after 78 hr of boiling are illustrated in Figs. 1 and 2.

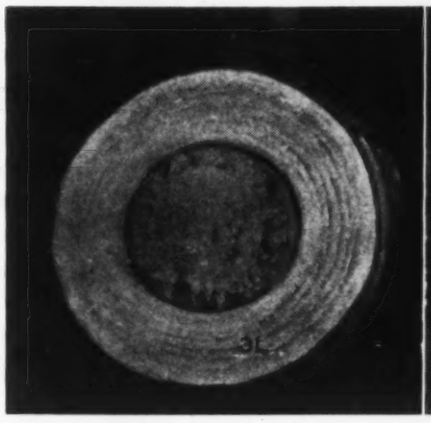


FIG. 1 LAMINATED-ASBESTOS PIPE COVERING BEFORE BOILING IN WATER

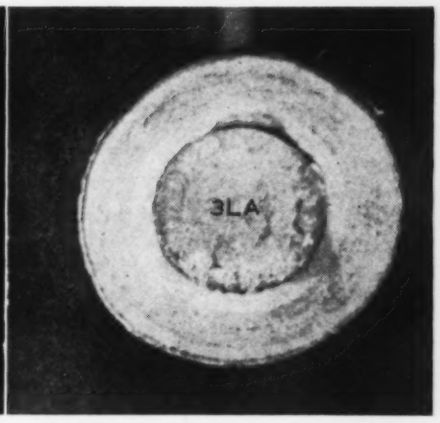


FIG. 2 LAMINATED-ASBESTOS PIPE COVERING AFTER BOILING IN WATER

COMMENT BY G. W. HEALD[6]

In spite of the large increase in the use of waterwall furnaces in small as well as in large boiler units, there exists and are continually being installed a far greater number of furnace walls of all-masonry construction. These furnace walls should not be excluded from appropriate study of the problems of maintenance, air infiltration, and heat emission, which are of paramount importance. It might be said that furnace maintenance is inversely proportional to the size of the furnace. Surely, some of the furnaces requiring repairs, which were originally installed 20 or 30 years ago, appear ludicrous when compared with modern combustion practice. There is plenty of engineering involved in getting the most out of such inadequate furnaces at a minimum or reasonable cost.

In the matter of "outside-wall temperatures that will permit comfortable working conditions," it is suggested that definite suitable temperatures for various types of plants be stated or proposed, in order that standard conditions may be established. How are such outside-wall temperatures determined?

Referring to the monolithic or refractory construction, which is shown in the illustrations, it can be said that present methods of construction result in walls which are free from air infiltration through joints and where the expansion and contraction are taken up within the wall itself.

In addition to the spall-resistant properties, the resistance to the flow of heat is substantially greater than through a similar thickness of prefired refractory.

[6] Chief Engineer, Ramtite Company, Chicago, Ill. Mem. A.S.M.E.

COMMENT BY H. G. HILL[7]

A few suggestions are offered herewith for the solution of problems, appertaining to the installation of insulation, as propounded by the authors:

Furnace Walls. Covering the outer surface of the insulation with panels of a firm heat-resisting material, such as an asbestos lumber, secured in place by steel battens at all joints, has been found quite satisfactory. This does not provide a hermetical seal but greatly diminishes the air leakage. In case of expansion or movement of the wall, the edges of the panels can move under the battens without causing any rupture of the surface.

Breachings. The common practice of mounting high-rib metal lath over the steel surfaces, onto which the insulation is applied, somewhat overcomes the damage to the insulation caused by expansion of the breeching. The high-rib lath can be placed across prominences, etc., affording a more or less even surface. This would cost much less than the rod-grille method referred to. As to applying insulation to the inside of the duct, there are various methods for doing this but the chief objection is the difficulty of observing the insulation; possible failures may thus be undetected.

Underground Steam Piping. Since the problem is to protect the insulation from becoming wet, reference might be made to a method which comprises an insulation directly combined with a waterproofing medium. In brief, this system consists of a 1-in-thick jacket of special high-melting-point asphalt, cast over the insulation on the inside of a sheet-metal casing, the insulation and asphalt protection being applied to the pipe at the factory and shipped in complete units direct to the job. Field connections can be easily sealed by surrounding the insulation on them with sheet-metal forms containing a 1-in. air space and pouring in melted asphalt. In this method the entire system from one end to the other is completely sealed against the entrance of water, no matter how wet the surrounding soil.

COMMENT BY J. A. KEITH[8]

This paper should promote considerable discussion on a phase of power-plant design too often given insufficient consideration. Those readers who have had any intimate contact with the operation of older power stations will know from experience how large an item the maintenance of heat insulation on pipes and ducts can become and how increasingly difficult it is to keep this insulation presentable in appearance. While there have been numerous new insulation products placed on the market during the last several years, methods of application have changed but little. Certainly, no change has been sufficiently great, either in the price of materials or methods of application, to offset the ever-increasing labor costs.

As the authors suggest, the presentation and publication of the paper may bring to light experiences and developments of others which may be correlated with existing data in the formulation of methods of insulation which will satisfactorily meet the present requirements. The problems which the authors mention, particularly with regard to expansion cracks, wrinkling and destruction of canvas covers, burning at points of minimum thickness over ribs, etc., are common experiences and too often accepted as unavoidable without thought being given to their solution. Designing engineers are prone to write specifications on standard recommendations of the product manufacturers without ascertaining first whether or not such specifications meet the particular requirements and whether or not they have a sufficient background of actual installations to prove their adequacy.

In the plants coming under the supervision of the writer, a change has been made in the method of insulating hot-water storage tanks, also open and closed heaters, which has proved a decided improvement from the standpoint of continued good appearance and greatly decreased maintenance costs. This change consisted of replacing the canvas covers with approximately $\frac{1}{8}$ in. (finished thickness) of a plastic-asphaltic coating troweled on over the smooth-finished cement, applied to the insulation blocks. This coating, which can be primed with aluminum paint and given a finish coat of any desired color, remains reasonably soft, ductile, and entirely free from the numerous cracks normally appearing in a smooth coat of asbestos cement. In case of damage, it is readily repaired and, in this respect, is certainly far superior to canvas. Furthermore, the covering is waterproof and remains intact under continued contact with water where a canvas jacket would come entirely loose.

This same type of covering is being used to some extent on air ducts, insulated externally. In this case, however, the frequent changes in temperature of the duct itself cause cracks to form at the corners. It is hoped that a scheme, now being tried, of using metal corner beads, something like those used in house plastering, may prove to be the solution to this difficulty.

The writer does not believe that the plastic-asphaltic coating would be satisfactory over long continuous runs of piping subjected to wide temperature variations. On the other hand, it is thought that it might work out well combined with the metal-banded expansion joints used by the authors, thus completely eliminating the canvas covers. The plastic-asphaltic covering saves nothing in first cost, as a matter of fact it is somewhat higher. However, in many cases it will ultimately save in maintenance cost.

Long vertical runs of pipe offer particular problems in heat insulation. Continued vibration, even though slight, causes a gradual working down of the block or segmental covering which results in cracks in the canvas or heavy wrinkles or both. Our present practice is to weld lugs at intervals to the surface of these vertical runs to afford support to the insulation, preventing an accumulation of weight on the lower pieces. This, the writer believes, will prove to be effective.

The authors' comment on the desirability of designing ducts for insulation on the inside surface is interesting. The writer admits that this is desirable but so far has found no satisfactory method for lining internally large gas flues, subjected to temperatures as high as 700 F. One particular duct in question carries the gases from the economizer to the air heater. This duct measures about 6 × 20 ft, the 20-ft dimension being horizontal. Block insulation was attached by means of heat-resisting wire to nuts welded to the duct. These blocks were plastered with air-setting refractory and insulating cement over wire mesh, likewise attached to the nuts. After a 4 to 6 months' run of the boiler some of the insulation and large quantities of the finish cement were found to have fallen off. Replacement of the refractory insulating cement was made, using J-M No. 450 cement. This, likewise, has failed. Cracks evidently develop and the high-velocity gases pull the covering off. It has been proposed to cover the finish cement with heat-resisting 10-gage plate attached by studs welded to the inside of the duct and projecting through the insulation. Such a plan would be expensive but may prove the ultimate solution. There is undoubtedly need for considerably more thought and investigation on methods and materials for inside duct lining under high-temperature high-velocity service.

Our company has run a number of ex

[7] Ehret Magnesia Manufacturing Company, New York, N. Y.

[8] Kansas City Power & Light Company, Kansas City, Mo.

periments during the last 3 years on various forms of outside duct-insulating materials such as Insulag, Eagle Picher 66, Detrich Plastic, and many others. Some of these appear to have considerable merit both from the point of view of first cost and appearance, as well as effective insulation. These materials have been used without canvas jackets and some of them have proved remarkably free from cracks with alternate heating and cooling.

The authors have not only presented several constructive ideas of their own in this paper but have opened a subject for discussion which we believe justifies much more thought and research than the power industry has given to it in the past.

COMMENT BY J. E. KENNEDY[9]

Viewing this paper through the eyes of the manufacturer and the contractor for installation of insulating materials, we are faced with the following problems:

Labor cost for the application of insulations has materially increased over the last 10 years and the efficiency of such application labor has materially decreased. This factor is one of paramount importance from the standpoint of the contractor, in that the increased cost of installing material must necessarily finally be borne by the user of insulating materials. With this in mind, as manufacturers we are constantly endeavoring to simplify our materials-application methods. This necessarily means, then, that the final purchaser or user of the insulating material should consult with the manufacturer or contractor sufficiently in advance of the preparation of specifications in order to avail himself of every possible avenue of information and design that will enable the manufacturer, contractor, and user to obtain the maximum of value at a minimum of cost. There has been a tendency on the part of many of the designers of, and specification writers for, insulating materials more or less to set up a list of acceptable materials and specifications written around the products of an individual manufacturer. Although this may or may not insure a source of supply of known quality, still, at the same time, it places on the defensive the manufacturers of other materials, as they do not feel as free to offer valuable suggestions as they do in cases where materials are specified according to a standard of insulating material, the type and qualification of which are based upon a technical rather than a manufacturer's description of the items involved.

Furnace Walls. The paper presents an excellent description of typical construction. We also are able to construct an insulated furnace wall that has proved eminently satisfactory. However, to do so we must have advance information and close cooperation from the ultimate user of the materials.

Duct and Fan Housings. If the designer and specification writer of insulations would consult with the manufacturer and contractor of insulating materials prior to the actual determination or detailing of the steelwork involved on ducts and fan housings, many of the troublesome problems now encountered could be eliminated.

Piping and Accessories. It is possible by the correct choice of methods greatly to lessen the troublesome features encountered on high-temperature pipe insulation, such as wrinkling of canvas, burning of canvas, etc. Again, the contractor should be given ample opportunity for consultation with the user to anticipate the problems prior to the award of the contract.

Underground Steam-Distribution Piping. The remarks under "Piping and Accessories" are equally applicable to underground steam-distribution piping.

Steam Turbines. With the advent of relatively high temperatures and pressures encountered in modern steam-plant turbine units, our former ideas of insulation must be revised to provide ample protection to the turbine, both during installation and in maintenance after installation. It is the writer's opinion that the ideal turbine insulation should consist of the following: The irregularities of the steel or metal housing should first be insulated with a plastic insulation of good adhesive quality and capable of withstanding the temperatures likely to be encountered. This plastic insulation should be applied and reinforced with suitable mesh reinforcement which in turn should be secured to proper welded fastenings. The surface of the plastic insulation should not necessarily be finished smooth, as would be the case in finished piping or surface insulations. Over this plastic insulation should be applied suitable pads made up of a high-temperature fabric or textile filled with an insulating material which will withstand the temperatures to be encountered and which will not have a tendency to dust when being replaced on the unit. Each should be properly identified for ready replacing after having been removed for maintenance of the turbine unit. The same type of insulation should be applied to the accessories, such as steam chest and valves, as pertain to the turbine proper.

Conclusion. Again, the writer repeats that the solution of many of the problems of insulation from an economical initial cost and relatively low maintenance cost can be achieved by closer coordination between the designer and specifications writer, the contracting applicator, and the manufacturer. Unfortunately, however, in many instances, the user will require competition among the applicating contractors over too wide a range, with the result that the applicating contractor will not disclose his full knowledge and suggestions because of fear of the information being passed to contractors of insulations whose thoughts are merely to get a job rather than to engineer and successfully install a high-class insulating contract.

COMMENT BY HARRY KNECHT[10]

Our method of fastening mineral-wool blankets to flat surfaces is not unique, but, because we believe that it is not widely used, it will be described in this discussion. No. 7 gage annealed iron wires, 3 in. longer than the thickness of the blanket, are welded at one end on approximately 12-in. centers to the surface to be insulated. These wires are left flat against the surface until the insulator is ready to apply the blankets. Then the wires are bent out perpendicular to the surface, the blankets are impaled on them, and the wires are then bent over flat.

In the application of single-layer Unibestos material to steam lines, the authors suggest covering this material with canvas. In a recent installation, our company used the same general method described by them but the canvas was omitted. The finished work was painted with one coat of gloss paint. While the surface did not have quite as fine a finished appearance as a neatly sewed or pasted canvas job, the result was acceptable.

In connection with the use of curly glass for packing expansion joints, the manufacturers of Unibestos material supplied us a glass wool roving having an asbestos cord woven around it. This had the advantage that, when the insulator took up enough of the material to gird the pipe, he always had a standardized quantity.

We hope more insulation manufacturers will put on the market, sectional material for larger-size pipe lines and that these materials will possess a suitable exterior surface, to be painted directly as a final finish.

[9] Manager, Engineering Sales Division, Plant Rubber & Asbestos Works, San Francisco, Calif.

[10] Division Engineer, Consolidated Edison Company of New York, Inc., New York, N. Y. Mem. A.S.M.E.

COMMENT BY M. H. STAUB[11]

There has been considerable carelessness in the purchasing and also in the application of insulation. Whether this has been due to too much "price buying" or to other factors is less pertinent to this particular discussion than the question as to what are some of the faults and shortcomings of insulation applications.

In their introduction, the authors refer to " . . . . . a consideration of the convenience of application, ... " This could be made a good deal more emphatic; there are too many cases where application labor is doubled and trebled due to inaccessibility, interference of other equipment, and poor location or both. Designers often need a better understanding of the manner of installing insulation on various types of equipment. To take a simple case, sometimes pipes are located within a few inches of a turbine shell, making special cuts of blankets necessary. Locating the pipe a few inches further out might make a substantial saving. Parts of the sheet-metal casing may be too close to permit the required thickness of insulation. The writer can report the case of a planished-steel casing for a 925 F turbine in which there was less than 1-in. clearance for insulation where at least 4 to 6 in. should have been provided. Pipes to be insulated are frequently so placed that pipe coverers have difficulty in reaching them, getting materials to them, or getting materials on.

When users of insulation demand good jobs, more attention will be paid to expansion joints, as the authors suggest. About the only places where expansion joints are common standards are on oil-industry towers and tanks. Even there, they are used only on the circumferential joints of some towers and tanks, when, as a matter of fact, there are yet more locations in which they could be used profitably. Here again, the authors have stressed a matter which should have received more consideration long ago.

In discussing "Piping for Fluids Below 50 F," the authors deal with a subject which constitutes a good illustration of what the writer terms "carelessness" in the application of materials. The writer has seen a number of cases of cold-pipe covering with so-called waterproof jackets and liners in which moisture-laden air entered through cutouts for hangers. Condensation occurred which traveled for several sections on both sides of the hanger, destroying the insulation on the inside. A correct installation would have all joints and cutouts thoroughly sealed with a good plastic waterproof compound. It must be remembered that breathing action takes place with changes in temperature and humidity, and even some waterproof felts will not constitute a fully reliable seal. Frequently laps are not sealed and these permit the entrance of moisture. The trouble here, as well as in many other cases, is that external appearance is too often taken as the criterion for a good job. Nothing could be further from the truth.

Most of the problems discussed in the paper are not, or rather should not be, considered as new. The authors should be congratulated on their willingness to consider matters which have been so long neglected.

[11] Assistant Manager, Industrial Insulation Division, Owens-Corning Fiberglas Corporation, Toledo, Ohio. Jun. A.S.M.E.

COMMENT BY R. M. VANDUZER, JR.[12]

The authors have discussed the question of insulating pads for turbines in some detail in the latter portion of the paper. It would add, perhaps, to the value of their conclusions on this subject to describe the experience of The Detroit Edison Company with three sets of turbine blankets made of glass fabric with glass-wool filler.

The first of this material was installed on a 75,000-kw 900 F turbine in 1938, while the remaining two sets were installed during 1939, on a 60,000-kw 825 F unit and a 10,000-kw 900 F superposed turbine. One large pad on the steam chest of the 75,000-kw unit was examined after 13 months in service and found to be in excellent condition. The blankets on the two large units have been generally quite satisfactory after more than a year in service, as only two cases of damage have occurred as a result of steam leaks. The pads on the small unit, however, were damaged considerably by steam leakage which occurred at the control- and stop-valve-bonnet joints during initial running of the turbine.

The moisture, which resulted from the leakage and was trapped by the planished-steel covering over the insulation, reacted chemically with some of the glass fabric, making it brittle. Most of the brittle patches were found in fabric next to the turbine casing where most of the moisture collected. More than one fourth of the pads were replaced and brittle spots in other pads were patched with new fabric. The filler material was not damaged and could have been reused.

It is our understanding that the manufacturers of this material now are investigating the effect of moisture and wet steam on the glass fabric, wool, and other materials which have been used for turbine insulation.

[12] Engineer, Production Department, The Detroit Edison Company, Detroit, Mich. Mem. A.S.M.E.

AUTHORS' CLOSURE

In the discussions on the various aspects of "A Study of Heat-Insulation Problems in Steam Power Plants," the contributors, who have ably presented the viewpoints of both producers and users of heat insulation, have offered many helpful suggestions and have given accounts of some interesting experiences. It is hoped that the following additional comments will reply satisfactorily to certain questions raised and augment other important portions of the discussions.

FURNACE WALLS

In line with Mr. Heald's discussion of the need for careful engineering in the application of insulation on solid-masonry boiler settings it should be mentioned that it is the responsibility of those sales representatives who have had wide experience in these problems and are familiar with the latest developments throughout the entire industry to inform the operators of small power plants regarding current insulation practices on which they cannot otherwise hope to keep posted.

The outside surface temperature of boiler walls can be obtained by using a contact-type thermocouple with a portable potentiometer or any one of several commercial contact pyrometers that are equipped with special tips for measuring the temperature of various types of surfaces. Aside from economic considerations, comfortable working conditions are generally found to prevail when the temperature difference between the warm exterior surface and the ambient air is not over 50 F and when adequate ventilation is provided in the building.

Covering the outer surface of the insulation on furnace walls with panels of insulation lumber held in place by battens, as suggested by Mr. Hill, may be quite satisfactory for some installations, but operators of large steam-generating equipment are seldom satisfied with anything short of complete prevention of air infiltration in settings, which justifies the use of all-welded steel casings.

DUCTS

Mr. Keith's experience with internal duct insulation seems to be typical. In many instances that have come to the authors' attention, the use of a metal lining fastened with studs welded to the outer metal casing has been attempted, but the results have been unfavorable because the conduction of heat from the in-

side metal surface through the studs to the external surface caused hot spots and burning of the paint over the studs. In some cases, unequal movement between the outside and inside metal sheets caused the studs to break off at the welds allowing the insulation to sag badly.

If the good and bad experiences of the manufacturers, contractors, and users of internal and external duct insulation could be made available, a very instructive paper could be written on this subject alone. It is apparent, from a perusal of the various discussions submitted, that individuals interested in the installation and maintenance of duct insulation are not in complete agreement concerning the relative merits of different types of construction and the possible success of internal insulation, although there seems to be accord in the opinion that duct insulation belongs on the inside if it can be made permanent. It is hoped that the ideas mentioned by Messrs. Bowman, Greider, Hill, Keith, and Knecht, with regard to duct insulation, will be augmented from time to time with published articles and discussions on other experiences with such installations so that constructive recommendations can be made for remedying the present difficulties, which seem to be widely prevalent.

PIPING

In reply to comments by Messrs. Bowman and Greider regarding the practicability and cost of double-layer vs. single-layer sectional pipe covering, it has been the experience of The Detroit Edison Company, first, that manufacturing variations in the dimensions of double-layer covering make it somewhat more laborious to fit on the pipe and to point with cement; second, that about a 10 per cent saving in labor cost can be effected by handling only one piece of material on the job instead of two; and third, that an appreciable saving results from warehousing and accounting for one item instead of two, particularly when it is realized that there may be from 50 to 75 different insulation items required in stock to cover the temperature range and pipe sizes encountered in power-plant practice. A recent change in insulation practice, standardizing on single-layer construction, has made it possible to reduce from 14 to 6 the number of items that are required for one typical pipe size throughout the entire temperature range.

The authors wish to confirm the remarks of Messrs. Keith and Kennedy that standard specifications actually do not fit enough cases to be applied without taking into account the user's specific requirements. Boilers, ducts, piping, and turbines are all tailor-made pieces of equipment and the insulation must be designed and installed to fit each case.

The use of asphalt-asbestos emulsion for surfacing insulation is gradually exciting greater interest and is becoming an extensive practice. It is true with the usual insulation construction that cracks will invariably develop owing to expansion and contraction of the piping or duct, but the use of expansion joints in the insulation, such as has been explained in detail by the authors and discussers, will permit an asphalt-asbestos coating to be applied on the continuous surfaces between the expansion joints without fear of cracking.

Users of sectional pipe covering on large size pipes installed with expansion joints in the covering will be glad to hear of Mr. Knecht's comment on the use of a glass roving in the expansion joint in place of the curly glass wool. It might also be mentioned that the use of canvas bands impregnated with colored temperature-resisting synthetic rubber is an improvement over the use of metal bands at the expansion joints. The canvas band retains its pliability without cracking and can be obtained to match the color of the paint on the adjacent pipe covering.

All users of insulation for large-size piping will endorse Mr. Knecht's statement: "We hope more insulation manufacturers will put on the market sectional material for larger-size pipe lines and that these materials will possess a suitable exterior surface, to be painted directly as a final finish."

UNDERGROUND STEAM-DISTRIBUTION PIPING

The selection and design of insulation for underground steam distribution piping has aroused considerable discussion by Messrs. Bowman, Crofts, Greider, and Hill, because it is still an important problem. It is evident from the variety of conditions encountered in the field and in the types of prefabricated and field constructions currently used, that any one solution is not a panacea. Each user establishes the economic bases, the space limitations, and the conditions that must be met in service. A system that may be suitable for one user may be uneconomical or too bulky for another.

It is recognized that laminated asbestos felt and other types of insulation for underground lines would not fail as readily if the steam formed in the covering, owing to occasional wetting, were permitted to escape readily rather than constrained by a more or less impervious waterproof felt jacket until it eventually escapes violently by bursting through the insulation assembly. However, if too frequent wettings occur because of the use of porous jackets, such as the wire-insulated asbestos cloth mentioned by Mr. Greider, the duration of time in which the insulation is wet greatly increases and results in a decided increase in the loss due to condensation of the steam in the pipe.

It cannot be emphasized too strongly that, as Mr. Staub has pointed out, designers of power-plant equipment on which heat insulation is to be installed, must exercise foresight in providing adequate space for the required thickness of insulation in order to simplify and facilitate the job of applying the material in the field.

The authors wish to express their appreciation for the fine response and cooperation of the discussers in submitting their excellent comments. These will help to stimulate the exchange of ideas and fulfill the object of the paper.

E. T. COPE.[13]
W. F. KINNEY.[14]

Turbine-Blade Fatigue Testing

COMMENT BY R. E. PETERSON[15]

In general there are two ways of conducting research toward improving the fatigue strength of machine parts: (1) Test various designs of actual machine parts, made of various materials of interest, in an apparatus which simulates the significant service conditions; (2) resolve the problem into its fundamental parts and investigate each part separately, i.e., determine theoretical stress-concentration factors, endurance limits of various materials under consideration, and sensitivity of the same materials to various degrees of stress concentration.

Procedure 1 is the obvious one generally used, since the immediate problem is usually to determine as quickly as possible the best design of several practical possibilities. Many examples of this procedure are to be found in industry, sometimes under the designation of "life tests." The machine, illustrated in Fig. 8 of this paper,[16] is being used in accordance with procedure 1 in the general program described. The following features are incorporated to simulate

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[14] Engineer, Research Department, The Detroit Edison Co., Detroit, Mich. Mem. A.S.M.E.

[15] Manager, Mechanical Division, Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa. Mem. A.S.M.E.

[16] "Turbine-Blade Fatigue Testing," by R. P. Kroon, MECHANICAL ENGINEERING, July, 1940, pp. 531–535.

blade conditions in service: (*a*) Fastening is identical in detail; (*b*) centrifugal pull applied by means of lever system; (*c*) alternating load applied at equivalent moment arm on blade; (*d*) temperature up to 1000 F obtained by electric furnace; (*e*) steam supplied by small jet (atmospheric pressure). While only a part of our test program has been completed, the results to date have been directly useful in design. Speaking in general, this type of testing (i.e., actual machine parts under service conditions) is widely used and should not, with our present state of knowledge, be put aside in lieu of more basic tests.

Coming now to procedure 2, which involves separate investigation of fundamental parts of the problem, some defense may be appropriate for such an elaborate approach. Where the form of construction is quite complicated, if the investigator merely tests one design after another, then, because of the many variables involved, he is not sure what is causing the differences in results and, therefore, may not arrive at the best design. To solve a problem of this kind basically is a lengthy procedure and, as a parallel method to procedure 1, can probably only be justified where a concern has a continuing variety of design problems of this same general nature and seeks to build up a more rational design system for the future. Specifically, the fundamental components of the fatigue-strength problem with respect to machine parts are:

(*a*) Theoretical stress-concentration factor. Only a few of the simplest cases can be handled mathematically, so that for practical cases this means a photoelastic determination. Incidentally, this field is being widened considerably by the new advances in three-dimensional photoelasticity.

(*b*) Endurance-limit values. This calls for systematic study of the various materials of interest, under different conditions of heat-treatment, surface finish, temperature, and atmosphere (the machines of Fig. 10 in the paper are for this purpose and in addition conventional rotating and tension-compression fatigue machines are also used).

(*c*) Sensitivity factors. It has been found that only under certain conditions is the full theoretical stress-concentration effect obtained in an actual fatigue test. From analysis of a large amount of test data it has been found that the percentage reduction depends upon the dimensions of the stress-raising portion of the machine part and the material.

In other words, if we have the theoretical factor which can be found rather quickly from a photoelastic test, if we know the endurance limit (a large amount of data are available), if we know the sensitivity factor (data are being continually accumulated), then we should be able to predict what time-consuming fatigue tests of machine parts (procedure 1) will give. Furthermore, we should be able to indicate conditions for optimum design by virtue of understanding clearly the effect of each variable. In a number of cases which permit accurate checking, we have been able to synthesize successfully and, as more experience is obtained, it is expected that this procedure will become more reliable.

We are, as indicated in the foregoing, using both methods in the blade problem, although in other cases because of expediency, we are limited to one, and more often than not conditions permit only an estimate based on the fundamental procedure.

COMMENT BY F. C. RATHBONE[17]

The advances in the field of research on turbine-blade fatigue failures, as described by the author, are of especial interest to those who like the writer were struggling with this problem a decade or more ago. The improvements in vibratory-testing apparatus, indicated by the author, make possible the accumulation and analysis of a great amount of varied and valuable data.

One of the early blade-testing machines developed at the Westinghouse, South Philadelphia Works, consisted of a block carrying several rows of blade segments which was automatically banged back and forth between anvils, until failure occurred. This was a combination of impact and free-vibration test, the forces being supplied by the inertia of the blades themselves. It was thus possible to determine by direct comparison the effect of various lashing-wire dimensions and locations, the effect of nicks and notches, rough edges, the rounding of lashing-wire holes, etc. Other testing machines in use at that time were of the oscillating crank and magnetic types.

The propriety of a balanced design with regard to the strength of the blade and the lashing wire was early recognized. It was also recognized that an arrangement which was ideal for the fundamental mode of vibration about a node at the root, might be very unfavorable for one of the higher modes with a node exactly at a lashing-wire hole. Many fatigue failures have started at such holes, progressing outward. In some cases cracks started at the outer hole of a long blade with a three-wire system, indicating fatigue at a higher mode of vibration. Thus the "traditional" and "arbitrary" rules mentioned had originally some basis of actual testing experience behind them.

The paper appears to deal with the fundamental modes of vibration only, i.e., nodes at the root, or the root and the central blade in a group, in the case of the "twisting" mode. However, the longer blades, particularly, may vibrate with two or more nodes along their length. It would be of interest to learn what has been the recent experience with regard to failures with this more complex vibration.

The vibrational stresses superimposed on the centrifugal and work stresses, which are responsible for fatigue failure in blading, are brought about by one of the following agencies:

1 Flutter, or self-induced vibration at the natural frequency of the blade, whatever it may be. Flutter does not involve resonance; it can be damped out but not tuned out. The flutter may involve the entire blade, or merely segments between nodes.

2 Steam pulsations, which are pronounced with partial-admission nozzles, but may also exist with full preceding stationary rows, either between individual blades, or at gaps in the horizontal joint or other discontinuities. The frequencies may be 200 or 300 times the operating speed and, thus, involve only the higher natural blade frequencies in the more complex vibration modes. A reflected pressure-wave or "sound-echo" phenomenon has often been suspected, such as might be caused by unsymmetrical projections or braces in the casing, but so far as the writer knows, no research has been carried out to explore this. Steam pulsations similar to the "steam squeal" in valves or in pressure reducers may conceivably affect blade vibration. Such vibration can be very destructive.

3 Torsional-oscillation impulses in the rotor, due to magnetic effects, occurring at multiples of the operating speed. Here, the vibrations are set up by the inertia of the blade itself. Natural frequencies at the fundamental or higher blade frequencies or at low multiples of the fundamental might be serious. Electric-type torsional oscillometers were developed to explore the magnitude and prevalence of such disturbances, but it is not believed that any conclusive data have appeared.

4 Bodily vibration of the rotor, as from unbalance. This vibration is lin-

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ear and normal as respects individual blades in some position, and generally occurs once, but sometimes twice, per revolution. Here again, the inertia of the blades supplies the vibrating force, and prime resonance occurs when the natural frequency of the blade is twice the operating speed.

5 Extraneous periodic forces attempting to vibrate the blades, such as an axial rotor vibration occasionally encountered, impacts due to play in coupling pins and gears, and blade wheel or ring keys. Rubbing contact at the blade tip or sides, producing chatter, is of course a more elementary cause of failure.

It is a fair statement to make that in practically every case the occurrence of blade failures is unpredictable, often mysterious, and always disconcerting. Explanations are at times unsatisfactory or unconvincing. By all precepts, the blades should not have failed. Sometimes a particular row in one turbine is prone to fail, while the same row in another presumably identical turbine does not fail. The failure of a single blade in a row of 300 or more exactly similar blades which have given no trouble after years of operation is not easy to explain. The usual suspicion cast on the blading material generally proves to be unfounded, except in the few cases where chrome-carbide precipitation has been in evidence. More recently high-temperature effects on physical properties have been shown to be responsible. Sharp nicks or other stress-producing elements are of course responsible for some otherwise erratic failures.

Although a blade may accumulate some 15,000,000 stress cycles during the first day it is in operation, which should cause failure if it is ever to fail, actual fatigue cracking generally does not appear until after weeks, months, or even years of operation, when the number of stress cycles reaches astronomical figures. A reasonable explanation seems to be that the condition, under which the blade-vibrating amplitude causes the endurance limit to be exceeded, is only transitory and sporadic, such as when the turbine is passing through some critical point on being brought to speed. In this case, if the turbine is shut down only once a week, months or years may be required to accumulate a sufficient number of stress cycles to start fatigue failure.

AUTHOR'S CLOSURE

Mr. Peterson's commentary about the two types of fatigue testing (one a life test of an actual or simulated assembly under operating conditions, the other a detail study of the different variables) is very significant. Which method to choose should be the primary consideration in any investigation of this kind.

The first procedure, while promising a quick and direct answer, usually requires elaborate special equipment and has the disadvantage that its data are of little value when there are design changes. This method is popular in the automobile industry, where life tests on car seats with bouncing weights, rocking tests on bodies, and so on, have found favor.

The second type of investigation is obviously limited to cases with a small number of variables. While taking much time, work of this kind can often be carried out with standard equipment. This fundamental approach seems to be indicated especially where the accumulated data can be used to predict the effect of design changes on similar parts.

Both methods of attack have been employed in the blade problem.

Mr. Rathbone's enumeration of various causes of blade failures should be of interest to the industry. While only the three principal modes of vibration, which generally have the lowest natural frequencies, were described in detail, the methods outlined in the paper apply to the higher modes as well. However, as one would expect, and as tests confirm, the higher modes are much less likely to be excited to a dangerous degree and are therefore much less important from our point of view. In standardizing lashing-wire dimensions, it appears logical to balance the design for the principal modes. An exception should be made in those rare cases in which large exciting forces of high frequency are known to occur.

Incidentally, failures of blades at the outer wires do not, by themselves, indicate a vibration in a higher mode. As Fig. 3 of the paper shows, this location is one of high stress concentration for the first mode of vibration.

The author shares Mr. Rathbone's amazement at the astronomical figures which the number of cycles to produce failures in service often reaches. In addition to Mr. Rathbone's explanations, it might be pointed out that while the blade vibrates a large number of cycles every revolution, yet the peak amplitude (which may be quite pronounced) occurs only once per revolution and the occurrence of this peak amplitude rather than the total number of cycles would be the determining factor.

Variables such as load, vacuum, and bleeder flow complicate this picture. We have a case on record of an old machine in which a blade stood up for years until a change in plant operation, resulting in drastic increase of bleeder flow of the particular turbine, produced rapid failure.

R. P. KROON.[18]

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A.S.M.E. BOILER CODE

Interpretations

THE Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Anyone desiring information on the application of the Code is requested to communicate with the Secretary of the Committee, 29 West 39th St., New York.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the Secretary of the Committee to all of the members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and passed upon at a regular meeting of the Committee.

This interpretation is later submitted to the Council of The American Society of Mechanical Engineers for approval after which it is issued to the inquirer and also published in MECHANICAL ENGINEERING.

Following is a record of the interpretations of this Committee formulated at the meeting of September 13, 1940, which were subsequently approved by the Council of The American Society of Mechanical Engineers.

CASE NO. 828

Revised item (3):

(3) The full thickness of the composite plate may be used in design calculations for Par. U-68 vessels provided the service temperature does not exceed 250 F, and for other vessels provided that both the service temperature does not exceed 250 F and the service pressure does not exceed 100 lb. For all other vessels the thickness of the carbon steel base plate only shall be used in design calculations.

CASE NO. 896

Revised item (3):

(3) The full thickness of the composite plate may be used in design calculations for Par. U-68 vessels provided the service

temperature does not exceed 250 F, and for other vessels provided that both the service temperature does not exceed 250 F and the service pressure does not exceed 100 lb. For all other vessels the thickness of the carbon steel base plate only shall be used in design calculations.

CASE No. 910

(Interpretation of Par. P-112)

Inquiry: Par. P-112 specifies certain diameter and thickness limits of pipe or tubes that can be welded in accordance with the requirements of this paragraph. It has been interpreted that pipe or tubes beyond these dimensional limits may be welded in accordance with the requirements of Pars. P-101 to P-110. Will it not meet the intent of the code for pipe or tubes beyond the dimensional limits given in Par. P-112, to be welded under the requirements of Par. P-112 with the additional requirement that the welds be radiographed under the requirements of Par. P-102?

Reply: The welding of pipe beyond the dimensional limits given in Par. P-112 under the rules in Par. P-112 with the additional requirement that all such welded joints shall be radiographed in accordance with Par. P-102(i), will meet the intent of the Code provided the welding process and the welding operator are qualified under the requirements of Par. P-112. It should be noted that this interpretation does not apply to boiler drums, but only to pipe used as such in the boiler or boiler component circulating system, and within the limits of the boiler up to and including the valve or valves as required by the Code.

CASE No. 911

(Interpretation of Par. U-68)

Inquiry: Are the test plates specified in Par. U-68(a) required when straight-sided nozzles are welded into a pressure vessel that comes under Par. U-68 classification but in which no longitudinal or circumferential welded seams are involved?

Reply: It is the opinion of the Committee that for the construction as outlined in the inquiry, no test plates need be made. However, the welding operators who do the welding on the nozzle must be qualified in accordance with Pars. UA-41 to UA-53.

REVIEWS OF BOOKS

And Notes on Books Received in the Engineering Societies Library

The Story of Superfinish

THE STORY OF SUPERFINISH. By Arthur M. Swigert, Jr., Director of Production Research for Chrysler Division, Chrysler Corporation, Detroit. Lynn Publishing Company, Detroit, 1940. Cloth, 6 × 9 in., 672 pp., $5.

REVIEWED BY JOHN M. LESSELLS[1]

THE engineer has known for a long time that the surface finish is an important aspect of the machining operation. That better finishes increase the fatigue strength of machine parts is generally accepted. More recently Gough and his associates have introduced us to an old phenomenon under the new name of fretting corrosion, which again is a surface phenomenon. The best bearings developed so far for the aero engine are copper, lead, or silver but their proper functioning depends on a thin coating either of lead plus indium or lead plus tin. This is merely a very thin plating which again emphasizes the role of surface condition in the performance of such parts.

"The Story of Superfinish," by A. M. Swigert comes at a time when more attention is being given to surface conditions. It would probably be nearer the truth to state that the work of the Chrysler Corporation in developing a better understanding and methods of producing superfinish, so well described in its pages, has made engineers interested in such surface phenomenon, and while we like to speak of "controlled finish" rather than "superfinish" there is no question that credit must be given the Chrysler Corporation for focusing attention on the subject and helping engineers, as D. A. Wallace mentions in his Foreword, to become "finish-conscious."

The book consists of twenty-one chapters beginning with an introduction and discussing in subsequent chapters the reasons for and importance of superfinishing. Chapter six is devoted to the measurement of surface finish. Chapters seven to thirteen discuss the various methods of obtaining superfinish. Included in this group is a chapter devoted to abrasives, tracing the early development and bringing this up to the use of bonded abrasives. Many valuable data are given on machining in general which cannot but be useful to all who are interested in machining processes. Chapter thirteen is devoted to the producing of superfinished surfaces and is followed by a chapter on bore processing. The next six chapters are devoted to the relation of lubrication to surface finish, to the metallurgical aspect of surface finish, to a description of machines for producing surface finish, and to the economic advantages.

The volume contains an immense amount of interesting figures and photographs and in addition there is injected into the test many terse phrases which makes the reading intensely interesting. There is no doubt that anyone who is interested in the subject of finish will do well to study carefully the material which is to be found within its covers.

[1] Associate Professor of Mechanical Engineering, Massachusetts Institute of Technology, Cambridge, Mass. Mem. A.S.M.E.

Corrosion of Iron, Steel

THE CORROSION OF IRON AND STEEL. By J. C. Hudson. D. Van Nostrand, Inc., New York, N. Y., 1940, 304 pp., halftones, charts, tables; $5.75.

REVIEWED BY F. N. SPELLER[2]

THE author is the official investigator for the Corrosion Committee of the British Iron and Steel Institute, and his book is an authorized review and summary of their work to date. As the study of ferrous corrosion in Great Britain centers in this National Committee and their five annual reports (now published) are naturally encumbered with data accumulated for several years in the course of experimental work, a digest of this kind is very welcome. The author has added to the usefulness of this book by including references to several extensive foreign corrosion investigations, such as those sponsored by the National Committee in Holland, American Society for Testing Materials, Na-

[2] Metallurgical Consultant, Pittsburgh, Pa. Mem. A.S.M.E.

tional Bureau of Standards, and various metal industries in this country. It is to be regretted that at least a condensed bibliography of recent reports on important corrosion work in the several countries was not included for reference.

The work of the British Committee covers mainly studies of the fundamentals with laboratory and field tests of bare and painted panels of iron and steel in the atmosphere, and of bare metals under marine conditions, and is an outstanding example of what can be accomplished by well-directed cooperative research.

The objective of this and the work of similar committees here and abroad is, of course, to prevent unnecessary waste and to decrease the cost of maintenance of iron and steel structures. All materials subject to test were prepared under known conditions of manufacture and, as a rule, were typical of the commercial products they represent. The data from field tests of copper steels and low-alloy steels show a definite advantage in life of these steels under atmospheric conditions, but in most cases the difference is not so marked as in American tests. Specific recommendations for preparation of metal surfaces for painting are given, which include removal of all mill scale to secure the best results. Dr. Hudson's book is a summary and contains many more interesting points. It is impractical within a short space to even mention these.

The amount of detail given on investigations of accelerated atmospheric-corrosion tests by intermittent drying and wetting suggests that such a test may yet be found that will parallel long-time exposure, but this may require the use of more than one reagent.

Some of the more recent low-alloy steels are naturally not included in the original program, but these and improved painting practice will no doubt be taken up by this committee. Nevertheless, the author points conservatively to fifty per cent reduction in atmospheric corrosion by the use of slower corroding structural steels and a very considerable decrease in maintenance by better methods of preparing the metal surface for painting and by improvements in paints. Metallic coatings, such as sprayed metals, are pointed out as promising developments for protection of even large steel structures in air and water.

The author recognizes the world-wide interest in this problem and the desirability of coordinating this work internationally. In this connection he refers to the recently organized American Coordinating Committee on Corrosion (headquarters 4400 Fifth Avenue, Pittsburgh, Pa.) sponsored by many of our national societies and research institutes.

The book is written in clear and popular style, well-illustrated, and should be of particular interest to corrosion engineers and paint technicians.

Flash!

FLASH! By Harold E. Edgerton and John R. Killian, Jr. Hale, Cushman & Flint, Inc., Boston, Mass. Cloth, $8\frac{1}{2} \times 11$ in., 200 pp., 280 illus., $3.

REVIEWED BY VICTOR SEPAVICH[3]

"FLASH" is written in a manner that should make it appealing not only to the ordinary layman and those unacquainted with the intricacies of stroboscopic photography, but also to the engineer and trained technician as well. The book is filled with examples of single and multiexposure stills and multiple-flash movies. Each illustration is accompanied by some description telling how the picture was taken or what was learned from the picture.

Birds, animals, and athletes form the bulk of the subjects illustrated. This does not mean that the stroboscope is limited in its application to subjects of this nature. On the contrary, these subjects were chosen because of the simplicity of the setup required to photograph them and the universal appeal of illustrations involving the subjects. It requires but little imagination readily to substitute a mechanical motion for any of the subjects in these illustrations in order to appreciate the many useful purposes to which the stroboscope can be put.

The bibliography at the end of the book is one of the most complete lists of various articles on high-speed photography that can be found.

Flow Measurement

FLOW MEASUREMENT BY MEANS OF STANDARDIZED NOZZLES AND ORIFICE PLATES. The American Society of Mechanical Engineers, New York, N. Y., 1940. $8 \times 10\frac{1}{2}$ in., 64 pp., 72 illus., $2.75; to A.S.M.E. members, $2.20.

THOSE who use flow nozzles and orifice plates for the measurement of fluid flow will welcome this latest A.S.M.E. contribution to the engineering literature of the subject. It presents in convenient form the most reliable and approved procedures for the use of flow nozzles and orifice plates in the measurement of the volume of fluids of various kinds.

The report was prepared by a joint committee composed of members of the A.S.M.E. Committees on Power Test Codes and Fluid Meter Research, of which William A. Carter was chairman. Consequently, its 64 pages present the latest results of the research on fluid measurements which has been in progress for some years combined with a full description of the standardized methods for these measurements which have been approved by the A.S.M.E. Power Test Codes Committee and the Society. Moreover, the high accuracy which these measurements assure makes the material especially suited to flow measurement connected with tests of performance to meet contract guarantees.

Flow measurement prescribes (*a*) certain primary elements, the proportions and coefficients of which have been established; (*b*) a recommended technique governing their use; (*c*) the necessary equations for computing the flow; and (*d*) the tolerances within which measurements may ordinarily be made.

The subject matter is treated in eight sections as follows: Section 1, introduction; section 2, letter symbols, which gives the standard series of letter symbols for use in equations and computations that has been accepted by the authorities in this field; section 3, equations and definitions; section 4, recommended technique, which covers fully such subjects as installation, primary measurements including differential pressure, inlet pressure, temperature, and secondary quantities, and is well illustrated with nine line drawings and graphs; section 5, primary elements, a detailed study of the design, fabrication, installation, use, and special characteristics of the four primary elements covered by this report, viz., I.S.A. nozzle, long-radius low-ratio nozzle, long-radius high-ratio nozzle, and orifice plates (48 line cuts and graphs are employed to illustrate the text and to present the data in the form for convenient use); section 6, tolerances for flow measurements by means of nozzles and orifice plates; section 7, computations and examples; and section 8, derivations of equations, which shows how the general flow equation may be developed and presents the factors for converting inches of mercury, inches of water and inches of mercury under water to pounds per square inch. An index is included.—C. B. LEP.

Books Received in Library

A.S.T.M. STANDARDS ON PETROLEUM PRODUCTS AND LUBRICANTS, prepared by Committee D-2 on Petroleum Products and Lubricants, September, 1940. American Society for Testing Materials, Philadelphia, Pa. Paper, 6×9 in., 354 pp., illus., diagrams, charts, tables, $2; 10 to 49 copies, $1.50 each. This annual

[3] Crompton & Knowles Loom Works, Worcester, Mass.

compilation is a convenient, compact source of all petroleum test methods, definitions, and specifications issued by the American Society for Testing Materials. The present report also includes three proposed new methods giving tests for neutralization number and aniline point and for ignition quality, and a revised Diesel-fuel-oil classification.

AEROPLANE CARBURETORS, Part 1. (Aeroplane Maintenance and Operation Series, Vol. 1.) Edited by E. Molloy and E. W. Knott. Chemical Publishing Co., New York, N. Y., 1940. Cloth, 6 × 9 in., 124 pp., illus., diagrams, tables, $2. This volume deals with the maintenance and repair of the more popular types of Hobson aero carburetors, which are used on a large range of British airplane engines. A section is included on the Hobson induction pressure control. The directions are detailed and explicit, and are illustrated by many drawings and photographs.

AEROPLANE INSTRUMENTS, Part 1. LANDING LEGS, WHEELS, AND BRAKES. AIRSCREWS, Part 1. (Aeroplane Maintenance and Operation Series, Vols. 2, 3, and 4.) Edited by E. Molloy and E. W. Knott. Chemical Publishing Co., New York, N. Y., 1940. Cloth, 6 × 9 in., 132 pp. each, illus., diagrams, charts, tables, $2 each. These three volumes of a new series on airplane maintenance and operation give careful, thorough descriptions, with many illustrations, of the respective items of equipment listed: Vol. 2. Aeroplane Instruments (Part 1). Deals with the operation and maintenance of the Sperry gyropilot, Sperry aircraft instruments and Smith's aircraft instruments. Vol. 3. Landing Legs, Wheels, and Brakes. Deals with the maintenance and repair of various commercial types of landing equipment including landing legs, shock absorbers, tail-wheel units, brakes, and tires. Vol. 4. Airscrews (Part 1). Deals with the maintenance and repair of the de Havilland controllable-pitch airscrews and hydromatic airscrews.

AIRCRAFT YEAR BOOK for 1940, 22nd edition. Edited by H. Mingos. Aeronautical Chamber of Commerce of America, New York, N. Y., 1940. Cloth, 6 × 9 in., 532 pp., illus., diagrams, maps, charts, tables, $5. This annual provides a record of developments in aviation during the last year, both at home and abroad. The work of the army and navy, the activities of the various Federal agencies and commercial firms are reviewed. Chapters are devoted to the present war, air lines, private flying, airports, training, and other fields of interest. The book includes tables of aircraft specifications, descriptions of aircraft and engine designs, a chronology of events and records, an aeronautical directory, and statistics of the industry.

COLLECTED RESEARCHES ON CYLINDER WEAR. By C. G. Williams, with foreword by Rt. Hon. Lord Austin. January, 1940, Institution of Automobile Engineers, Automobile Research Committee, London, England, 1940. Cloth, 6½ × 9½ in., 119 pp., illus., diagrams, charts, tables, 10s. The major part of this work consists of reports on experiments conducted in the laboratory of the Institution of Automobile Engineers. An introductory chapter summarizes published information from other sources, and recent experiences of manufacturers and operators are discussed in a later chapter.

DETECTION AND IDENTIFICATION OF WAR GASES, Notes for the Use of Gas-Identification Officers. Ministry of Home Security, Air-Raid Precautions Department, London, England. First American Edition, Chemical Publishing Co., New York, N. Y., 1940. Cloth, 5½ × 9 in., 53 pp., tables, $1.50. A brief discussion of the general properties of war gases precedes specific information about the physical and chemical properties of the important types. Principles and methods of gas detection and chemical identification are concisely presented, and the duties, the responsibilities, and the equipment of gas-identification officers are described.

ELECTROCAPILLARITY. By J. A. V. Butler. Chemical Publishing Co., New York, N. Y., 1940. Cloth, 5½ × 9 in., 208 pp., illus., diagrams, charts, tables, $5. This book deals with potential differences at electrified interfaces, the origin and nature of the effects that arise therefrom, and with electrode equilibria and kinetics. The work reviewed is that of the last fifteen years and touches many fields, from the behavior of proteins to the passivity of metals. Most attention has been given to topics which are not adequately treated in other works.

ELECTRONIC PROCESSES IN IONIC CRYSTALS. By N. F. Mott and R. W. Gurney. Oxford University Press, New York, N. Y.; Clarendon Press, Oxford, England, 1940. Cloth, 6 × 10 in., 275 pp., illus., diagrams, charts, tables, $5.50. The aim of this book is to develop the theory of the movement of electrons in ionic crystals, and to interpret experimental facts in terms of the theory. The Born theory of cohesion in ionic crystals and the Wagner-Schottky theory of ionic conductions in solids are described as an introduction. The succeeding discussions cover the absorption of light by ionic crystals, with the resulting photoconductivity and luminescence; the properties of semiconductors; and the insulating properties of nonconducting materials, including breakdown in high fields. Chemical reactions in solids are briefly considered in the final chapters.

ELEMENTARY FLUID MECHANICS. By J. K. Vennard. John Wiley & Sons, Inc., New York, N. Y., 1940. Cloth, 6 × 9½ in., 351 pp., illus., diagrams, charts, tables, $3.50. In order to present a more comprehensive idea of the basic physical principles of fluid mechanics the mathematical development has been carefully limited. The following topics are discussed: physical properties, fluid statics, frictionless flow, similarity and dimensional analysis, frictional processes, pipe and open-channel flow, measuring apparatus, and flow about immersed objects. Brief bibliographies and groups of problems accompany each chapter.

ENGINEERING MECHANICS. By S. Timoshenko and D. H. Young. Second edition. McGraw-Hill Book Co., Inc., New York, N. Y., and London, England, 1940. Cloth, 6 × 9 in., 523 pp., diagrams, charts, tables, $4. In this new one-volume edition, covering both statics and dynamics, the necessary reduction was accomplished by rewriting certain sections and omitting the more specialized discussions. The statics section contains general considerations of plane forces and space forces with a chapter on the principle of virtual displacements. Rectilinear and curvilinear translations and the motions of a rigid body are discussed in the dynamics section, including a short chapter on relative motion. Special attention has been given to selection of the problems with respect to their practical value.

ENGINES OF DEMOCRACY. By R. Burlingame. Charles Scribner's Sons, New York, N. Y., 1940. Cloth, 6 × 9½ in., 606 pp., illus., diagrams, maps, $3.75. The history of modern America is viewed in the light of its technological advancement. As the developments in the fields of metallurgy, electrical communication, power, printing, highways, illumination, and chemical synthesis, are reviewed, their contribution to our present way of life is stressed. The book closes with a discussion of modern trends and of the social inventions which must follow the technical ones. There are a bibliography, a chronological list of events and inventions, as well as a very full index.

FUNCTIONS OF THE ALLOYING ELEMENTS IN STEEL. By Dr. E. C. Bain. American Society for Metals, Cleveland, Ohio, 1939. Cloth, 6 × 9 in., 312 pp., illus., charts, tables, $4. A series of lectures presented before the American Society for Metals is published in this volume. The topics of the five lectures are: The fundamental characteristics of steels; alloying elements in unhardened steels; effects of alloying elements in forming austenite; effects of the elements in hardening steel; effects of alloying elements in tempering. There are many illustrative graphs and diagrams.

HANDBOOK OF ENGLISH IN ENGINEERING USAGE. By A. C. Howell. Second edition. John Wiley & Sons, Inc., New York, N. Y., 1940. Cloth, 5 × 8 in., 433 pp., illus., diagrams, charts, maps, tables, $2.50. Rules for proper English covering word selection, sentence construction, style, arrangement, punctuation, and grammar are clearly presented. Succeeding chapters discuss the composition of business letters, reports, and technical magazine articles. A great many examples from published material are included to demonstrate current practice.

HANDBOOK OF MATHEMATICAL TABLES AND FORMULAS. Compiled by R. S. Burington. Second edition. Handbook Publishers, Sandusky, Ohio, 1940. Leather, 5 × 8 in., 275 pp., diagrams, $1.25. A compilation for students and workers in scientific and technical fields. The first part of the book contains a collection of formulas and theorems of algebra, trigonometry, analytic geometry, calculus and vector analysis, and comprehensive tables of derivatives and integrals. Part two contains the usual logarithmic and trigonometric tables to five places, with many other tables of various numerical quantities. Certain sections have been changed or enlarged from the first edition.

HISTORY OF THE COLT REVOLVER and the Other Arms Made by Colt's Patent Fire Arms Manufacturing Company from 1836 to 1940. By C. T. Haven and F. A. Belden, with a foreword by S. V. Grancsay. William Morrow & Co., New York, N. Y., 1940. Cloth, 8 × 11 in., 711 pp., illus., diagrams, tables, $10. This handsome volume is an authoritative account of the invention and development of the Colt revolver, based upon the records of the Company and other students and upon study of the revolvers themselves. The book includes a history of all Colt models, a complete list of all Colt revolvers prior to the twentieth century; a collection of letters, price lists, advertisements, and other documents relating to their manufacture; and facsimiles of patents from 1836 to 1880. There are 163 half-tone illustrations of Colt arms, as well as many other illustrations. The book will be welcomed by all those who are interested in collecting firearms and students of their history.

INSTALLATION AND MAINTENANCE OF ELECTRIC MOTORS. (Electrical Engineer Series, Vol. 3.) Edited by E. Molloy. Chemical Publishing Co., New York, N. Y., 1940. Cloth, 5 × 8 in., 180 pp., illus., diagrams, charts, tables,

$2. The installation and maintenance of both small and large electric motors are described in a clear, concise manner, treating both mechanical and electrical features. There are many starter wiring diagrams among the numerous illustrations.

INVENTORS AND ENGINEERS OF OLD NEW HAVEN. (New Haven Tercentenary Publications.) Edited by R. S. Kirby. New Haven Colony Historical Society, New Haven, Conn., 1939. Cloth, 6 × 10 in., 111 pp., illus., diagrams. This attractive little volume contains six lectures given under the auspices of the School of Engineering in Yale University. The subjects are: Eli Whitney; early New Haven inventors; early Yale inventors; early Yale engineers; the formative years of New Haven's public utilities; the founding of the Sheffield Scientific School. The book contains a number of excellent portraits and will have permanent interest for students of engineering history.

KINEMATICS OF MACHINES. By G. L. Guillet. Fourth edition. John Wiley & Sons, Inc., New York, N. Y., 1940. Cloth, 5½ × 9 in., 300 pp., illus., diagrams, charts, tables, $3. Fundamental mathematical analyses and useful graphical constructions of motions in machines are presented in this elementary college textbook. The subject material has been selected with regard to the students' previous knowledge and the time allowed for the course. There is a group of drafting-room problems, and a set of review questions accompanies each chapter.

MACRAE'S BLUE BOOK and Hendrick's Commercial Register. Forty-eighth edition, 1940–1941. MacRae's Blue Book Co., Chicago, Ill., and New York, N. Y., 1940. Cloth, 8 × 11½ in., 3623 pp., illus., $15. The new edition of this well-known and useful directory follows the plan of preceding ones. It includes an alphabetical list of manufacturers, producers, and wholesalers, with the addresses of branch offices; a minutely classified list of products, with an extensive index; a list of towns of one thousand or more population, with their trade facilities and railroad connections; and a list of trade names.

MAKING YOUR PHOTOGRAPHS EFFECTIVE. By J. A. Lucas and B. Dudley. McGraw-Hill Book Co., Inc. (Whittlesey House), New York, N. Y., 1940. Cloth, 6 × 9½ in., 385 pp., illus., diagrams, charts, tables, $5. This practical manual discusses all phases of photographic work. Fundamental processes, cameras and other equipment, darkroom construction, and print making are described; exposures and lighting problems are considered; and a great variety of methods of work is presented. Many photographs are included to illustrate various parts of the discussion.

MANUAL OF INDUSTRIAL HEALTH HAZARDS. By J. B. Ficklen. Service to Industry, West Hartford, Conn., 1940. Cloth, 6 × 9½ in., 176 pp., illus., diagrams, charts, tables, $4. This manual presents methods for evaluating the health hazards from exposures to various dusts, vapors, and gases that occur in industry. The book opens with directions for air sampling. Following this, the occurrence, uses, properties, clinical symptomology, physiological response, and method of estimation are given for over ninety noxious dusts and gases. An accompanying table shows the potential health hazards in various industries.

MARINE DIESEL ENGINE STANDARDS, published by Diesel Engine Manufacturers' Association, New York, N. Y. Edited by M. J. Reed and O. A. Sibley, 1940. Cloth, 6 × 9½ in., 141 pp., diagrams, charts, tables, $2. In addition to presenting standard practices for all phases of installation and application in marine work, of Diesel engines and accessories, this book also gives information on standard performances and definitions, classification and marine inspection, and includes some statistical material.

MASCHINENFUNDAMENTE UND ANDERE DYNAMISCHE BAUAUFGABEN, part 2, by E. Rausch. V.D.I. Verlag, Berlin, Germany, 1940. Paper, 5½ × 8½ in., 370 pp., illus., diagrams, charts, tables, 25 rm. This second volume of Dr. Rausch's work illustrates the ways in which the comparatively simple principles underlying the design and construction of machine foundations are applied to practical problems, by presenting twenty-four actual examples in full detail. The examples are of cases of reciprocating or rotating machines of low or medium speed, and include foundations for steam engines, steam pumps, compressors, Diesel engines, hammers, and ore crushers.

MODERN SHIPFITTER'S HANDBOOK. By W. E. Swanson. Cornell Maritime Press, New York, N. Y., 1940. Leather, 5 × 7½ in., 269 pp., illus., diagrams, charts, tables, $2.50. Written for the shipyard worker, this handbook takes up in order the four major stages in a ship's construction: mold-loft work and template making; structural shopwork and anglesmithing; preassembly of sections; and erection of parts and sections on the ways. Chapters on blueprint reading, riveting, rigging, and welding are included, with a glossary of ship construction terms. There are many large working drawings.

MODERN THEORY OF SOLIDS. By F. Seitz. McGraw-Hill Book Co., Inc., New York, N. Y., and London, England, 1940. Cloth, 6 × 9½ in., 698 pp., diagrams, charts, tables, $7. This book surveys the theory of the properties of all types of crystalline solids, treating them from a common viewpoint. Besides dealing with the theory of metals, the book discusses the properties of salts and other insulators as well, showing the factors which account for differences and similarities among these materials.

NONFERROUS FOUNDRY PRACTICE. By J. Laing and R. T. Rolfe. D. Van Nostrand Co., Inc., New York, N. Y., 1940. Cloth, 5½ × 9 in., 336 pp., illus., diagrams, charts, tables, $6. The whole field of foundry practice for nonferrous metals and alloys is covered. Molding practice for each group of alloys is introduced by a detailed consideration of the constitution and properties of the whole range of alloys in the group. Mechanical test requirements, the effects of additions and impurities, and various uses of the alloys are treated. The first two chapters discuss molding sands and melting furnaces.

OIL IS WHERE YOU FIND IT. By S. Mims. Marshall Jones Co., Boston, Mass., 1940. Cloth, 5 × 8½ in., 236 pp., $2.50. A contemporary picture of oil in the southern and southeastern districts of the United States is presented in narrative form. The trials and tribulations, as well as the lure and excitement of the "oil game" are demonstrated in the lives of the chief characters in the book.

PRACTICAL MECHANICS AND STRENGTH OF MATERIALS. By C. W. Leigh and J. F. Mangold. Third edition. McGraw-Hill Book Co., Inc., New York, N. Y., 1940. Cloth, 5 × 8 in., 498 pp., diagrams, charts, tables, $3. This volume presents those principles of mechanics and strength of materials that are believed to be essential for the practical man. In order to develop the two subjects as a whole, each chapter on strength of materials is preceded by those principles of mechanics necessary for its presentation. The many illustrative problems are new in this edition, and considerable material has been added.

PUMPS. By F. A. Kristal and F. A. Annett. McGraw-Hill Book Co., Inc., New York, N. Y., and London, England, 1940. Cloth, 6 × 9 in., 339 pp., illus., diagrams, charts, tables, $3.50. A practical treatment of pumping problems for the designer, manufacturer, sales representative, operator, and student. Types and designs of pumps are described, and such important applications as boiler feed, deep wells, sumps, and sewage are given extended treatment. Pump installation, operation, and supervision are also treated, including troubles and remedies.

PYROMETRY OF SOLIDS AND SURFACES. By R. B. Sosman. American Society for Metals, Cleveland, Ohio, 1940. Cloth, 6 × 9½ in., 98 pp., illus., diagrams, charts, tables, $2.50. Three lectures prepared for the American Society for Metals are presented: 1, Scientific foundations of the pyrometry of solids; 2, the pyrometry of metals by means of thermocouples; 3, radiational pyrometry of solids and surfaces. A brief list of references is included.

REFRIGERATING DATA BOOK. Vol. 2, Refrigeration Applications. American Society of Refrigerating Engineers, New York, N. Y., 1940. Cloth, 6½ × 9½ in., 413 pp.; Catalog section, 148 pp., illus., diagrams, charts, tables, $4. The "Refrigerating Data Book" published in 1939 covered the principles of refrigeration and the machinery used. The present volume supplements it with a comprehensive account of the industrial applications of refrigeration and air conditioning. Freezing processes, refrigeration in processing, cold storage, food distribution, and air conditioning for comfort and in industry are presented practically and thoroughly.

RUBBER AND RAILWAYS. By C. Macbeth. Second revised edition. British Rubber Publicity Association, 1 Albert Mansions, Lansdowne Road, Croydon, Surrey, England, September, 1939. Paper, 5 × 8½ in., 216 pp., illus., diagrams, charts, tables, free on request. This publication describes in detail the ways in which railways (chiefly British) have applied the properties of rubber in their designs. A large part of the text consists of descriptions of actual applications, varying from drawbar springs to pneumatic tires. There is a large number of detailed section drawings.

STATISTICAL MECHANICS. By J. E. Mayer and M. G. Mayer. John Wiley & Sons, Inc., New York, N. Y., 1940. Cloth, 6 × 9 in., 495 pp., diagrams, charts, tables, $5.50. Both classical and quantum mechanics are used as the basis of this elementary treatment of statistical mechanics. Fundamental statistical laws are derived, and the principles of application to various simple energy states are discussed. Certain special operations are combined in an appendix. There are a large glossary of symbols and a small group of illustrative problems.

STRENGTH OF MATERIALS, Part 1. Elementary Theory and Problems. By S. Timoshenko. Second edition. D. Van Nostrand Co., Inc., New York, N. Y., 1940. Cloth, 6 × 9 in., 359 pp., illus., diagrams, charts, tables, $3.50. The elementary theory contained in this textbook for undergraduates covers analysis of stress and strain, shearing force and bending moment, beam and column theory, torsion and the energy of strain. Moments of inertia of plane figures are worked out in appendixes, and a group of problems accompanies the discussion of each new topic.

STRENGTH OF MATERIALS. By A. Morley. Ninth edition. Longmans, Green & Co., London, England, and New York, N. Y., 1940. Cloth, 5½ × 9 in., 571 pp., illus., diagrams, charts, tables, $4.20. The essential theories of strains and stresses in mechanical and structural elements are presented in this standard work, together with descriptions of testing machines and methods. Considerable revision has been made in the material on fatigue, elastic strength, creep, and other rapidly expanding fields. Illustrative examples accompany each chapter.

STRUCTURAL PLANNING AND DESIGN. By W. Glendinning. Apply to author, 5123 Bell Boulevard, Bayside, Long Island, N. Y., 1940. Paper, 8 × 11 in., 87 pp., diagrams, manifold, $2.10. This book contains the solutions of problems on structural planning and design given to applicants for the license of Professional Engineer by the New York State Board of Examiners. Over 160 problems are given, being those given in the examinations from January, 1933, to January, 1940. The problems are indexed by classes. The book will be of value to those preparing for examinations.

SUPPORTING STRENGTHS OF CAST-IRON PIPE FOR WATER AND GAS SERVICE. (Iowa Engineering Experiment Station, Bulletin 146, June, 1940). By W. J. Schlick. Iowa State College, Ames, Iowa, June 5, 1940. Paper, 6 × 9 in., 128 pp., illus., diagrams, charts, tables, free upon application. This investigation of cast-iron pipe under field conditions was conducted in cooperation with the American Standards Association. The investigation produced (1) an empirical method for determining the safe combination of external load and internal pressure, and (2) safe design values of the strength ratios for pipe laid in various representative manners. The complete experimental data and analytical study are presented.

SYMPOSIUM ON NEW MATERIALS IN TRANSPORTATION, Detroit Spring Meeting, March 6, 1940, American Society for Testing Materials, Philadelphia, Pa. Cloth and paper, 6 × 9 in., 94 pp., illus., diagrams, charts, tables; paper, $1.25; cloth, $1.50. Exhaust-valve materials for internal-combustion engines, automotive steels, rubber, concrete, asphalt, volatile liquid fuels and lubrication are the topics covered in the seven papers comprising this symposium. Major current developments are emphasized and probable significant trends are indicated.

TABLES OF CIRCULAR AND HYPERBOLIC SINES AND COSINES FOR RADIAN ARGUMENTS, prepared by the Federal Works Agency, Work Projects Administration for the City of New York, as a Report of Official Project No. 765-97-3-10. Arnold N. Lowan, Technical Director, U. S. Bureau of Standards, Washington, D. C., 1939. Cloth, 8 × 11 in., 405 pp., $2. This volume, the third of a series of mathematical tables, contains values of circular and hyperbolic sines and cosines to 9 places of decimals for a range of X from 0 to 1.9999 at intervals of 0.0001. Some supplementary and conversion tables are included.

TABLES OF SINES AND COSINES for Radian Arguments, prepared by the Federal Works Agency, Work Projects Administration for the City of New York, as a report of Official Project No. 765-97-3-10; A. N. Lowan, technical director; conducted under the sponsorship of the National Bureau of Standards, Washington, D. C., 1940. Cloth, 8 × 11 in., 275 pp., tables, $2. The major part of this fourth volume of a special series of mathematical publications consists of a table of values of sin x and cos x to eight decimal places at intervals of 0.001 from 0.000 to 25.000. Supplementary tables give values of sin x and cos x to various numbers of decimal places for other ranges and intervals, values of $p(1 - p)$, and conversion tables from radians to degrees and vice versa.

TECHNICAL DRAFTING, a Text and Reference Book on Graphics. By C. H. Schumann. Harper & Brothers, New York, N. Y., and London, England, 1940. Cloth, 6 × 9½ in., 793 pp., illus., diagrams, charts, tables, $3.50. This volume has been designed not only as a comprehensive textbook on engineering drafting but also as a professional reference book. The first part presents the elementary principles of the subject. The second part goes intensively into commercial practice in the various branches of engineering, including welded construction and both architectural and topographical drafting. There are many illustrative problems, and certain useful data are contained in an appendix.

TECHNICAL DRAWING. By F. E. Giesecke, A. Mitchell, and H. C. Spencer. Second edition. The Macmillan Co., New York, N. Y., 1940. Cloth, 6 × 9 in., 687 pp., illus., diagrams, charts, tables, $3. The science of technical drawing is comprehensively covered, including such special applications as architectural and topographic work and the reproduction of drawings. Among several new chapters in this edition is one on welding representation. There are many practical examples and problems, and lists of symbols, data tables, specifications, and a bibliography are appended.

TEXT-BOOK OF HEAT, Part 2. By H. S. Allen and R. S. Maxwell. The Macmillan Co., New York, N. Y., and London, England, 1939. Cloth, 5½ × 9 in., 848 pp., illus., diagrams, charts, tables, $3.50. This book is intended to supply the need for a work occupying a position between an elementary textbook and a comprehensive treatise. This second part of the work is of a theoretical and advanced character. It starts with the laws of thermodynamics and, after dealing with conduction, convection, radiation, and other special subjects, ends with an elementary consideration of statistical methods and the quantum theory. Probability is given special attention.

THEORY OF GROUP CHARACTERS and Matrix Representations of Groups. By D. E. Littlewood. Oxford University Press, New York, N. Y.; Clarendon Press, Oxford, England, 1940. Cloth, 6½ × 10 in., 292 pp., diagrams, tables, $5.50. This book presents a simple, self-contained account of the theory of group characters in its application to finite and continuous matrix groups, and elaborates some of its applications. Preliminary chapters on matrices, algebras, and groups precede the development of the theory. Applications to the theory of symmetric functions and to the structure of groups are dealt with in some detail. In the last two chapters the theory is generalized to certain continuous matrix groups. There are twenty pages of character tables and a large bibliography.

THEORY OF PLATES AND SHELLS. By S. Timoshenko. McGraw-Hill Book Co., Inc., New York, N. Y., 1940. Cloth, 6 × 9 in., 492 pp., diagrams, charts, tables, $6. This volume is concerned with the problems of deformation which are encountered by the designer of ship hulls, laterally loaded concrete slabs, domes, thin-walled tanks, boilers, and other structures in which the thickness of the material is small in comparison with the other dimensions. The discussion of the general theory of plates is limited to a minimum, and most of the book is devoted to the investigation of particular problems, for which general solutions are developed and, in many cases, complete numerical calculations as well. Tables give values of deflections and stresses for plates of various proportions under various load conditions. The work is an Engineering Societies Monograph.

U. S. PATENT SYSTEM. By J. A. Dienner. American Society for Metals, Cleveland, Ohio, 1940. Fabrikoid, 6 × 9 in., 73 pp., diagrams, tables, $1. This volume contains three lectures presented to the Chicago Chapter of the American Society for Metals. The distinctive features of the U. S. patent system are described, reasons for their establishment and continued use are presented, and controversial issues are explained. Recent legislative activity is discussed. There is a bibliography included.

VARIABLE BUDGET CONTROL, Through Management by Exception and Dynamic Costs. By F. V. Gardner, with a foreword by C. R. Messinger. McGraw-Hill Book Co., Inc., New York, N. Y., and London, England, 1940. Cloth, 6 × 9 in., 357 pp., illus., diagrams, charts, tables, $4. This treatise on variable budget control shows what it is, demonstrates its advantages over static budgeting, and describes and illustrates in detail how to develop, install, and administer a variable budget system. The object of the book is to explain how to develop controls that show what is happening in a business rather than what has happened.

VECTOR METHODS, Applied to Differential Geometry, Mechanics, and Potential Theory. By D. E. Rutherford. Oliver and Boyd, Edinburgh, Scotland, and London, England; Interscience Publishers, New York, N. Y., 1939. Cloth, 5 × 7½ in., 127 pp., diagrams, 4s, 6d, $1.50. The purpose of this little book is to provide a clear account of the abstract theory of the vector calculus and a brief but broad survey of the applications of the theory to various branches of pure and applied mathematics. It is intended for the use of undergraduates.

WILEY TRIGONOMETRIC TABLES. John Wiley & Sons, Inc., New York, N. Y., 1940. Cloth, 5½ × 9 in., 81 pp., tables, $.75. This collection aims to present, with accuracy and in clear type, the tables most used by students of trigonometry. The tables are: squares and square roots; constants with their common logarithms; natural logarithms of numbers; five-place logarithms of numbers; logarithms of functions; and four-place values of functions and radians.

WORKING, HEAT TREATING AND WELDING OF STEEL. By H. L. Campbell. Second edition. John Wiley & Sons, Inc., New York, N. Y., 1940. Cloth, 6 × 9 in., 230 pp., illus., diagrams, charts, tables, $2.25. This work is planned to assist in the introductory study of certain phases of the metallurgy of steel, and aims to present principles and practice concisely, without including terms and discussions which properly belong to more advanced studies. Appended to the text is a series of twenty laboratory assignments.

WORKING STRESSES. By J. Marin. Rutgers University Press, New Brunswick, N. J., 1940. Cloth, 5½ × 8½ in., 41 pp., diagrams, charts, $1. The selection of the correct working-stress value for the design of a structure or machine is discussed in this small volume. Working stresses for static and fluctuating loads are first considered; then combined states of stress including fatigue and creep conditions are analyzed. Illustrative graphs accompany the text and there is a list of references.

A.S.M.E. NEWS

And Notes on Other Engineering Activities

Hotel Astor to Be Scene of 1940 A.S.M.E. Annual Meeting

Program of 105 Technical Papers and 44 Sessions Necessitates Shift From Society Headquarters

AN unusually heavy program of technical papers and sessions to be crowded into the space of four active days commencing December 2 has necessitated the holding of the 1940 Annual Meeting of The American Society of Mechanical Engineers at the Hotel Astor, in Times Square, instead of the Engineering Societies Building, the Society's headquarters in West Thirty-Ninth Street, where previous meetings have been held. This important change should be borne in mind by all persons planning to attend the meeting in order to avoid delay and confusion.

Registration, technical sessions, many social events, including luncheons and dinners, will be at the Hotel Astor except as specifically noted in the official program, an advance edition of which was published in the November issue and distributed by mail to all members.

As usual a series of inspection trips to local plants of interest to mechanical engineers, including a visit to the largest passenger vessel ever built in a shipyard in the United States, the S.S. *America*. New York's new airport at North Beach, La Guardia Field, will also be an attractive feature for many engineers, as will the new Sixth Avenue Subway, the Queens Midtown Tunnel, and the 35-mile belt parkway. Trips to industrial and power plants covering a wide range of special interests are also being provided.

In conformity with usual practice, Wednesday evening has been set aside for the Annual Banquet at the Hotel Astor, where speakers of national reputation will be heard. Provision for entertainment of women is being made by the New York Section of the Woman's Auxiliary to the A.S.M.E.

Also at the Astor will be found the annual photographic exhibit of A.S.M.E. members and other participants. In addition to the regular exhibit of photographs there will be a display of photostats of early automobiles—of the vintage of the eighteen-thirties—from the collection of Sidney Withington, electrical engineer, of New Haven, Conn. Mr. Withington has collected a wide variety of illustrations, including many cartoons relating to early self-propelled road vehicles of a century ago.

Other features of an unusually complete and varied program will be fully noted in the official programs to be distributed at registration.

HOTEL ASTOR HEADQUARTERS FOR 1940 A.S.M.E. ANNUAL MEETING IN NEW YORK

Materials Handling Session at Annual Meeting Part of Defense Program

THE important session (Wednesday Dec. 4, 9:30 a.m.) of the Society of Naval Architects and Marine Engineers with the Materials Handling Division of the A.S.M.E. on the subject of "Materials Handling Methods at Ports and Terminals" is part of the program of National Defense. It marks the first cooperative activity of an extensive series planned between the two Societies, for which a joint committee has been set up. This session will feature facilities necessary for the rapid and efficient loading and unloading of munitions and war materials on and from ships and their handling in railroad cars, in warehouses, and on the piers. The modern methods explained will considerably improve and lower the cost of such services for peacetime operations, as well.

A.S.M.E. Holds Second of Series of Meetings on Shell Manufacture

Army Officers, Manufacturers of Shell-Making Equipment, and Shell Manufacturers Gather at Cincinnati, Oct. 16–17

A.S.M.E. history was made once more at Cincinnati when a group of nearly three hundred engineers and executives gathered in the Roof Garden of the Gibson Hotel, on October 16 and 17 to take part in the second meeting of The American Society of Mechanical Engineers on the manufacture of shell, a continuation of the highly successful meeting at Pittsburgh on September 11, reported on pages 762 to 764 of the October issue. Organized under the auspices of the Cincinnati Section of the Society in association with the Metals Engineering and Machine Shop Practice Divisions, the newly formed Ammunition Group, and the Army Ordnance Association, the morning and afternoon session of the first day on the forging of shell and the morning session of the second day on shell machining attracted keenly interested audiences that seemed determined to secure a maximum of information from the various speakers and from those who took part in the ensuing discussions.

Muller Speaks on Role of Army Ordnance Department

Col. James L. Walsh, chairman of the A.S.M.E. Committee on National Defense, brought the meeting to order at 9:30 a.m. and introduced the first speaker, Edward A. Muller, past-president A.S.M.E., chief of the Cincinnati Ordnance District, and president of the King Machine Tool Company. Pointing out that nations have become great as they developed means of securing their territory against the ever-present threat of aggression, Mr. Muller laid emphasis upon the importance

to humanity of the epoch-making innovations in the military art and paid tribute to those upon whom is now falling the burden of rearming this country with all possible speed. He also made complimentary references to the able and efficient work of the Army Ordnance Department, especially as that relates to the preparation of specifications for shell. More important, perhaps, than the guns which fire them, shell must perform its assigned task with a maximum of safety to those behind the guns.

Specifications for Shell Steel

Lt-Col. Miles W. Kresge of the Army Ordnance Department was the next speaker. Upon the Ordnance Department falls the difficult task of reconciling shell-steel specifications with those various factors which have an important bearing on the final result. First and foremost the shell must fulfill its assigned function; but the practical considerations of steel production, the forging of the carcass and its subsequent machining, must all be taken into account in framing those specifications. Free-machining, high-sulphur, high-manganese steels are now being used so that the shell may be machined accurately and rapidly. In so far as these specifications relate to dimension, the shell machiner wants forgings which are of minimum weight, while the shell forger would like permission to produce billets with large tolerances and a generous percentage of excess metal for economical production. Complicating the situation is the matter of a possible shortage of manganese, necessitating perhaps, at some future time a change in specifications. Then there are those who, in straining for the highest effectiveness from the standpoint of fragmentation would like to insist on a laboratory steel, requiring expensive and time-consuming heat-treatment of the steel. Steels X1335 and X1340, used for 75-, 90-, 105-, and 155-mm shell, are the present metallurgical answer to these conflicting requirements.

Heating Billets for Shell Forging

W. Trinks of the Carnegie Institute of Technology presented the second paper of the Wednesday morning session. In discussing the heating of billets for shell forging, Professor Trinks pointed out that in heating billets to the required forging temperature of 2200 F, we are interested in securing uniform forging temperature, in producing a scale (since we cannot heat practically without producing scale) which can be removed easily, and in the lowest possible cost of operation. In securing these ends we have to decide upon the relative suitability of the batch-type, the straight-line continuous pusher-type, and the rotary-hearth furnace. All of these furnaces are adaptable to the purpose of shell-billet heating, each having its own advantages and limitations. Whichever type is selected, it must be capable of accurate control to the end that the steel is heated at the proper rate and that melting around the corners and along the edges is avoided. Most important is uniformity of temperature because of its influence on accurate centering of the piercing punch, a difference of only a few degrees being sufficient to produce deflection. Commenting on general principles of heating for forging, Professor Trinks observed that heat should be applied as rapidly as the billet would take it, without cracking or overheating at the edges or corners, and followed with diminishing rates as the steel warms up, finishing with just enough heat for a final soaking to insure uniformity of temperature.

In the discussion which followed this paper, Alan Dauch of the George J. Hagan Company pointed out that the heating time in the rotary-type heating furnace is about 60 per cent of that required in the pusher-type or batch-type. On the other hand maintenance cost is slightly higher in the case of the rotary furnace because of its greater mechanical complication. Further discussion revealed that the pusher-type furnace is simple to operate while scaling and slag formation is highest in the rotary furnace and lowest in the batch-type unit.

J. B. Doan Speaks at Luncheon

Following a rousing welcoming speech by the Honorable James Garfield Stewart, Mayor of Cincinnati, J. B. Doan, president of the Cincinnati Chapter of the Army Ordnance Association and chairman of the board of the American Tool Works Company, delivered the luncheon address in the course of which he complimented those present at the meeting for the part they were playing in the greatest world drama of all time. "Time was—when we were young—when we believed in the invincibility of the United States of America and of the ability of the American soldier to do battle against any and all comers. Then there was certainty in the protection offered by thousands of miles of ocean and while we have a long front to defend, we have a long front to attack. Proud as we are of our glorious record, it must be plain that in the kind of warfare being waged today courage and devotion are no match for the mechanized legions which threaten us, if unsupported by arms. Even as we are gathered here at this meeting," Mr. Doan said, "more than sixteen million young men over the nation are signing up for service in the armed forces of the nation." We must see to it that this devotion is matched by our united efforts toward supplying them with arms. "Then if fight we must, let's fight with all we have to the finish."

Methods of Forging Shell Discussed

The afternoon session on Wednesday was opened under the presidency of Robert T. Kent, production engineer, Ordnance Department, U. S. Army, by a presention by Professor Frank Macconochie of the department of engineering, University of Virginia, of an analysis of shell-forging equipment. After defining acceptability as this term is applied to shell forgings, the various methods of shell forging now finding favor in this country were outlined and their respective merits discussed. The forging machine, when properly designed and when the requisite care is given to tool design, is readily adapted to the forging of shell. While its production rate cannot compare with the claims made for the newer pierce and rolling or drawing procedures, the nature of the operations is conducive to long tool life and the machine, once acquired, is readily turned over to peacetime applications. Among the more spectacular developments in shell-forging techniques are the Witter cross-roll and the "one-shot" method in which the bottom of the die is allowed to descend at a predetermined rate and in such a manner that the entire operation is completed with one stroke of the punch.

In the discussion which followed, A. Waltman of the Clearing Machine Corporation announced that his company is building an automatic machine which should produce about 480 shell per hour, delivering them on a conveyer. The unit comprises a furnace and forging machine connected in such a manner that the only labor required is for loading the furnace. The next contributor was Morris D. Stone, United Engineering and Foundry Company, who presented an extremely able paper on the flow of metal during forging operations on shell and based on experiments carried out with lead. These experiments not only showed the manner in which the metal in the billet is distributed but showed the relations between the pressures required and the stroke of the punch for various punch profiles. Reference was also made to the one-shot forging process previously mentioned, and a motion picture of the press at work was shown.

Colonel Harmon Speaks at Dinner

A fascinating account of "Tanks in Action" was the main feature of the dinner meeting. This was presented by Col. E. N. Harmon, First Armored Corps, Fort Knox, Kentucky, who contrasted the employment of the tank by the British and French on the one hand and the German armies on the other. German strategy calls for the use of infantry in an exploratory process which reveals the weak links in the enemy defense. Thereafter the line is broken and the tanks pour through the breach to invade the enemy's rear, smash communications, and produce demoralization. Reference was also made to that fateful decision by a German commander on the banks of the Meuse which sealed the fate of France. A single pontoon bridge connected the two banks of the river. French divisions were approaching. To cross or not to cross, with no recourse in the event of the destruction of the bridge and the consequent cutting of his armored forces in two—that was the question. He crossed in safety and the battle of France was won.

Machining of Shell

On Thursday morning, October 17, with Erik Oberg, editor of *Machinery* in the chair, Tell Berna, general manager of the National Machine Tool Builders' Association, opened the session with an address on "Cooperation Between the Government and the Machine-Tool Builders," in the course of which reference was made to the single-purpose shell lathe, designed for the army by the machine-tool industry and capable of turning a shell a minute. The Studebaker Corporation has built the first of these machines and has it in operation on an endurance test. The reason for preparing these designs was that in the event of war, or perhaps even a threat of war, the Army would have at its disposal tested designs of a machine which could be built rapidly and without benefit of a highly organized machine-shop. In speaking of the part played by machine tools in national defense, Mr. Berna stated that the industry has doubled its output during the last twelve months and will have a

At the A.S.M.E. Meeting on Manufacture of Shell, Cincinnati, Ohio, Oct. 16–17

[(1) James L. Walsh, presiding at opening session, and Edw. A. Muller, past vice-president A.S.M.E., right. (2) Lt-Col. M. W. Kresge, Ordnance Department, U. S. Army. (3) J. B. Doan, center, Col. E. N. Harmon, assistant chief of staff, G-4, Armored Force, Fort Knox, right, and A. F. Macconochie, left. (4) Prof. Arthur F. Macconochie, University of Virginia. (5) M. D. Stone, manager, development department, and John L. Young, general manager, machinery sales, United Engineering & Foundry Co. (6) Prof. W. Trinks, Carnegie Institute of Technology. (7) Lucien I. Yeomans, Lucien I. Yeomans, Inc. (8) E. S. Sauerbrunn, chairman, Cincinnati Section A.S.M.E., Babcock & Wilcox Co., James G. Stewart, Mayor, Cincinnati, Ohio, center, and Edw. A. Muller, right. (9) Sol Einstein, vice-president, Cincinnati Milling Machine Co., and H. J. Wills, right, Carborundum Co. (10) R. T. Kent, production engineer, Ordnance Department, U. S. Army, and George F. Schranz, right, general manager, Baldwin Southwark Division, Baldwin Locomotive Works. (11) Chas. A. Witter, special representative, Salem Engineering Co. (12) Edw. A. Muller and Warner Seeley, Warner & Swasey Co.]

much larger expansion during the coming year. One of the major bottlenecks is the lack of trained men. "However," he observed, "machine tools are only one element in national-defense production. Many other types of machinery are also needed. Plants have to be built, men trained, and large numbers of gages, jigs, and fixtures made available. Then all of these elements must be coordinated before large-scale production actually gets under way. The machine-tool industry is confident that it will be able to produce the machine tools required just as rapidly as plants are ready for their installation and the men ready to operate them."

Classification of Surface Finish

H. J. Wills of the Carborundum Company, in his paper on the classification of surface finish, said that the question of surface finish had not yet emerged from a state of fogginess, misconception, and personal interpretations. Mr. Wills first defined the "nominal surface" and then proceeded to describe the nature of the deviations from this ideal surface, including flaws, waviness, and "roughness." Roughness means those random irregularities which may be supposed to be imposed on the nominal or wavy surface. On smooth machined surfaces the distance between the "high spots" is ordinarily between 0.0002 and 0.010 in. and their height is very much less than their width, this latter being between 0.000001 and 0.0005 in.

The microinch, or one millionth of an inch, is the generally accepted and most convenient unit of measurement for surface irregularities. For some purposes the scale and determination of roughness should be representative of the maximum single deviation from the nominal surface, while for a majority of applications, the average deviation from the nominal surface is of greater significance.

Shell-Machining Equipment

Lucien I. Yeomans was next on the program with an analysis of shell machining equipment, in which he contrasted the policies of utilizing the simpler types of shell turning lathe and more especially the single-operation machine, with the modern tendency toward putting as many operations as possible on one multi-spindle automatic. Mr. Yeomans very candidly expressed his preference for the former, pointing out that inexperienced labor can be trained much more readily to operate the single-purpose lathe than to handle the more complicated automatic. Further there is much less risk of serious delays in the event of one operation breaking down. It is only fair to add that Mr. Yeomans' views do not by any means receive universal acceptance, many machine-tool builders, out of the wealth of their own experience, being at variance with him.

As far as the problem of shell production is concerned, it would probably be wise to encourage the use of the simpler and more easily constructed machines, reserving the highly developed automatic for other urgent tasks for which it is eminently fitted.

The meeting was under the organizational direction of A. F. Macconochie, professor of mechanical engineering, University of Virginia.

250 Register at Joint A.S.M.E.-A.I.M.E. Coal Meeting in Birmingham, Ala.

Sessions Devoted to Preparation and Utilization of Coal

WITH true Southern hospitality the Southeast Section of the A.I.M.E. and the Birmingham Section of the A.S.M.E. acted as hosts to the Fourth Annual Joint Meeting in Birmingham, Ala., Nov. 7–10 of the Coal Division of the mining engineers and the Fuels Division of the mechanical engineers. Headquarters were at the Tutwiler Hotel. Four technical sessions were devoted to the preparation and utilization of coal.

Commissioner Green Welcomes Guests

At the opening session, Commissioner W. Cooper Green, chairman of the City Commission, welcomed the two hundred and fifty registrants. He described the industries of Birmingham and its ranking in the nation. The proximity of coal, iron, and limestone gives promise of the rapid development of the section into the Pittsburgh of the South.

At the close of the first session the members attended a luncheon addressed by Mr. Herbert C. Stockham, president of the Stockham Pipe and Fittings Company and president of the Associated Industries of Alabama. Mr. Stockham's address on the approaching national problems, as influenced by recent world conditions, left his audience with the feeling that the manufacturers of the nation are planning and putting into effect full cooperation with the federal government.

In the afternoon, because of the full program, it was necessary to hold two simultaneous technical sessions. The Coal Division session had as its theme the preparation and burning of coal while the Fuels Division concentrated on boiler-furnace design and combustion problems.

Stag Smoker Great Success

Thursday evening was devoted to entertainment in the form of a stag smoker. Prominent radio artists entertained the crowd. Ernest Hartford insisted that the five-dollar prize he won by guessing most nearly the correct number of kernels of corn in an urn was won by applying the principles of engineering estimating. The Birmingham hosts overestimated the capacity of their northern guests and provided about twice the amount of beer that could be consumed. The mechanicals felt that they could lord it over the miners by reason of winning the guessing contest and Steve Moxley had a lot of fun with Herb Salmon over the result. Community singing is entered into wholeheartedly in the South and it was enjoyed thoroughly at the stag.

Inspection Trips

On Friday morning four separate inspection trips left the hotel promptly at 9:00 a.m. taking the members to the more important local industries and converging at the Thomas Plant of the Republic Steel Corporation where the members and their ladies were guests of the Company at a luncheon of fine southern fried chicken. Immediately after lunch the group boarded a train of the Tennessee Coal, Iron and Railroad Company at the Thomas Plant and spent the afternoon on a train tour of the industrial Birmingham Valley. Some stops were arranged at suitable observation points where the members climbed the towers overlooking the valley. Coal and ore mines, preparations plants, blast furnaces, and steel mills were on the itinerary. The train returned to Birmingham where buses carried the members through the fine residential sections of the city to the historic statue of Vulcan and returned to the hotel.

Governor Dixon Speaker at Banquet

That evening the Governor of the State of Alabama, Frank M. Dixon, addressed the Joint Meeting at its annual banquet. The excellent food left the group in fine shape to hear one of the finest speeches to which many of them had ever had the pleasure of listening. The Governor talked particularly to the guests from outside of the state and informed them of Alabama's problems, their source, and how it is proposed to solve them.

The closing technical session was held on Saturday morning with the two Divisions again meeting jointly. In spite of the football fever which had taken hold so strongly in the South, attendance held up to the first day's high standard. Thanks of the Divisions and the national societies were conveyed to the Birmingham Sections for the splendidly conducted meeting.

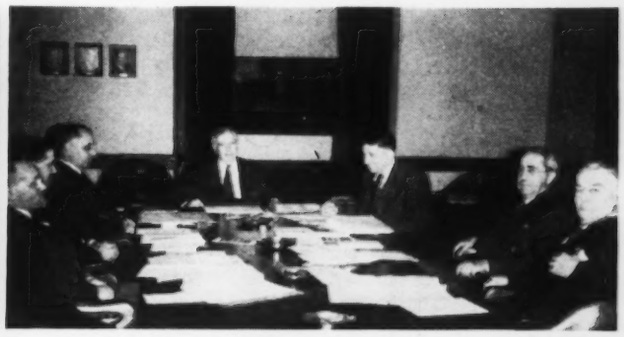
In the afternoon the group saw the Red Tide (Alabama) defeat the Green Wave (Tulane) in a game in which even the visitors found it hard to be neutral.—A. R. MUMFORD.

N.Y.U. Course in Research-Laboratory Management

IN recognition of the rapid development of industrial research, combined with its growing importance in the national-defense program, the New York University College of Engineering will offer an evening course of lectures in research-laboratory management.

The outline of the course has been planned in cooperation with an advisory committee of industrial-research executives headed by Maurice Holland, director, Division of Engineering and Industrial Research, National Research Council, who suggested the course; Dr. W. A. Gibbons, director of development, United States Rubber Company; H. W. Graham, director of metallurgy and research, Jones and Laughlin Steel Corporation; Lewis N. Waters, vice-president, General Foods Corporation; Dr. Franklin Cooper, Haskins Laboratories; and Robert B. Colgate, vice-president, Colgate-Palmolive-Peet Company.

The course will begin in February, 1941, and will be offered in the department of administrative engineering under the direction of Dr. L. P. Alford, chairman of the department, and the advisory committee.



A.S.M.E. COMMITTEES ON MEETINGS AND PROGRAM AND PROFESSIONAL DIVISIONS MAKING PLANS FOR THE 61ST ANNUAL MEETING OF THE SOCIETY

(The first photograph shows the Committee on Meetings and Program hard at work at the meeting of Sept. 20. The industrious gentlemen are, starting at the left of the table, A. L. Kimball, N. E. Funk, L. K. Sillcox, Erik Oberg, chairman, Ernest Hartford, secretary, W. J. Wohlenberg, and G. L. Lingner. The second shot of the Committee on Professional Divisions, taken on May 24, includes, starting at the left, G. B. Karelitz, W. A. Carter, Victor Wichum, Harte Cooke, chairman, Ernest Hartford, secretary, C. T. Ripley, and L. H. Fry, a guest at the meeting.)

Ralph Budd 1941 John Fritz Medalist

THE John Fritz Medal Board of Award has awarded to Ralph Budd, president of the Chicago, Burlington & Quincy Railroad, the John Fritz Medal for 1941 for "the improvement of railroad tracks and service, especially the introduction of lightweight streamlined trains."

Highest Engineering Award

In the United States the John Fritz Medal is referred to as the highest award of the engineering profession because it is awarded by a board comprised of 16 representatives of the four national engineering societies of civil, mining and metallurgical, mechanical, and electrical engineering, having a combined membership of sixty thousand. The representatives of The American Society of Mechanical Engineers on the board which made the award are William L. Batt, James H. Herron, Harvey N. Davis, and A. G. Christie.

Ralph Budd was born August 20, 1879, in Waterloo, Iowa. He received a degree of B.S. in C.E., Highland Park College, Des Moines, Iowa, 1899. Beginning his career in 1899, Mr. Budd has been an outstanding leader in the field of American transportation. He was chief engineer in charge of construction of the new Panama Railroad; president of the Great Northern Railway during construction of the Cascade Tunnel, and the relocation and electrification of the line. He made inspection and report in 1930 on rehabilitation and rationalization of Soviet railways. He now is president of the Chicago, Burlington & Quincy Railroad, and its various subsidiaries, including the lines in Colorado and Texas. He also is a director of the First National Bank of Chicago and the International Harvester Company, and is a member of the American Society of Civil Engineers, the American Railway Engineering Association, and the Western Society of Engineers.

Medal Established in 1902

The John Fritz Medal was established in 1902 as a permanent memorial to John Fritz, former president and honorary member A.S.M.E., who had distinguished himself in improving methods for the manufacture of steel and in molding the foundations of our industrial world. He was greatly beloved by his contemporaries and as a tribute to him, the medal was established and is awarded from time to time in recognition of distinguished achievement in that field of endeavor typified by his work, "that the name and life of John Fritz may be a power for good through the years, in the fields of applied science in which he had made himself so eminent, and that it will keep bright the luster of that name."

Library Reports Stoppage of European Technical Magazines

IN spite of the war, the Engineering Societies Library is experiencing no difficulty in its receipt of technical periodicals from Great Britain. However, only a few engineering magazines reach the Library now from Continental Europe. The 350 or more periodicals from England and other parts of the British Empire are coming through with unusual regularity except in one or two instances since the beginning of the war when the ship carrying them was sunk. However, correspondence with the publishers soon brought replacements for all lost copies.

The Allied blockade of Germany failed to stop the flow of German magazines to the Library through Italy. But, with the entrance of the latter country into the war, German and Italian publications were not received for several months. Now, some of the German periodicals are being received again through Siberia and Japan, as indicated by the postmarks on the wrappers. *Genie Civil* and other French periodicals ceased arriving at the Library a few weeks after the surrender of France.

To avoid the loss of valuable publications being sent to and received from the British Isles and Continental Europe through exchange agreements between engineering institutions there and the Engineering Societies Library and its cooperating organizations, namely, American Society of Civil Engineers, American Institute of Mining and Metallurgical Engineers, The American Society of Mechanical Engineers, and the American Institute of Electrical Engineers, arrangements have been completed to store them in the country of origin until the end of hostilities. Similar arrangements during the World War proved so satisfactory that only one or two sets of foreign periodicals failed to be completed with the resumption of commerce between belligerents.

H. A. Lardner Re-Elected President U.E.T.

UNITED Engineering Trustees, Inc., at its annual meeting on Oct. 24, 1940, elected officers for the ensuing year. Henry A. Lardner, fellow A.S.M.E., was re-elected president. Other officers elected are J. P. H. Perry and Albert Roberts, vice-presidents; Walter Kidde, member A.S.M.E., treasurer; W. D. B. Motter, Jr., assistant treasurer; and John H. R. Arms, member A.S.M.E., secretary and general manager. The Corporation maintains its offices in Engineering Societies Building, which it owns for the engineering societies, conducts engineering and scientific researches, and has the largest free engineering library in the world.

Official Notice

A.S.M.E. Business Meeting

THE Annual Business Meeting of the members of The American Society of Mechanical Engineers will be held Monday afternoon, December 2, at 2:00 p.m. at the Hotel Astor, New York City, as a part of the Annual Meeting of the Society, December 2–6, 1940.

The Annual Report of the Council and other Committee reports will be presented for the action of the members. There will be an opportunity also for members desiring to do so to bring any other business before this meeting.

(*Signed*) C. E. DAVIES
Secretary

A.S.M.E. Calendar
of Coming Meetings

December 2–6, 1940
Annual Meeting
Hotel Astor
New York, N. Y.

April 1–3, 1941
Spring Meeting
Atlanta, Ga.

June 16–20, 1941
Semi-Annual Meeting
Kansas City, Mo.

October 12–15, 1941
Fall Meeting
Louisville, Ky.

(For coming meetings of other organizations see page 28 of the advertising section of this issue)

Industrial Executives to Visit South America

PRELIMINARY plans for a visit to South American countries in early 1941 by a representative group of industrial and research executives of the United States, under the auspices of the National Research Council, to observe and study industrial possibilities and research activities, were reviewed on October 22 at a meeting in the Engineers' Club, New York, by the Committee of Survey and Report of the National Research Council's proposed project. The committee, of which Chauncey L. Williams, of New York, vice-president of the F. W. Dodge Corp., is chairman, has been studying the various aspects of the trip for more than a year.

Development of practical methods for interchange of industrial technology as developed by 2200 research laboratories in this country was described as a major objective of the South American trip by Maurice Holland, director of the National Research Council's division of Engineering and Industrial Research. Cooperation of various departments of the government charged with the responsibility for inter-American relations has been assured the National Research Council, which would sponsor the trip, Mr. Holland said.

A representative of the National Research Council will make a preliminary inspection tour of specific points of industrial interest in South America, for the purpose of making the visit as fully effective and productive of results as possible.

The chairman of the National Research Council's Division of Engineering and Industrial Research is William L. Batt, fellow and past-president, A.S.M.E., president of SKF Industries, Inc.

Inter-American Relations Subject of A.A.A.S. Meeting, Philadelphia, December 31

ECONOMIC and engineering interests of the Americas will be the major theme of the annual meeting of Section M (Engineering) of the American Association for the Advancement of Science, to be held in Philadelphia, Dec. 31, 1940. Through the courtesy of the Engineers Club of Philadelphia the facilities of the club, centrally located at 1317 Spruce St., have been offered for the morning, afternoon, and luncheon meetings.

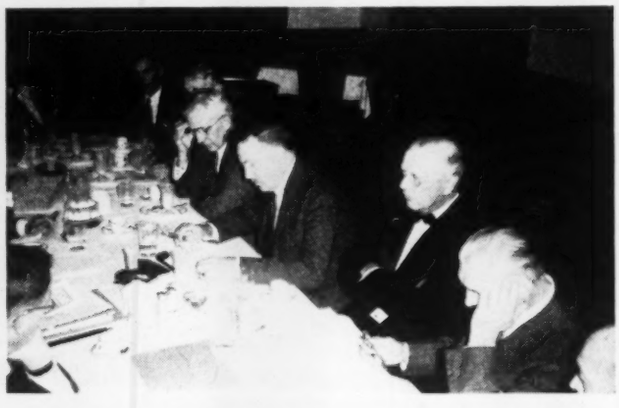
Presiding at the opening session which immediately follows registration at 9:30 a.m. will be Robert L. Sackett, fellow A.S.M.E., who is vice-president of Section M. Jerome C. Hunsaker, member A.S.M.E., retiring vice-president of Section M, will speak on "Aviation Progress," Cloyd Heck Marvin, president, The George Washington University, on "Educational Relationships Between the Americas," and Raymond Clapper, newspaper correspondent, Washington, on "The Press and Inter-American Relations."

At the luncheon, to be held at the Engineers Club at 12:30 the speaker will be William S. Culbertson, former United States Ambassador to Chile. Speakers at the afternoon session will be Fred Lavis, consulting engineer, New York, whose subject will be "Engineering Developments in South America," and C. L. Warwick, secretary, American Society for Testing Materials, who will discuss "Inter-American Engineering Standards." The tentative program also provides opportunity for a discussion of United States scholarships for South American students.

The program of the meeting was developed in cooperation with George Howland Cox, director of the Inter-American Center of The George Washington University and the officers and directors of Section M, F. M. Feiker, secretary. Local arrangements are in charge of C. L. Warwick. The meetings are open to all interested.

Mathematicians Propose National-Defense Plans

UPON the suggestion of a War Preparedness Committee, the following resolutions were adopted at a joint meeting of the American Mathematical Society and the Mathematical Association of America held at Dartmouth College, Sept. 9–12, 1940: (1) That all competent students in the secondary schools take the maximum amount of mathematics available in their institutions; (2) that the college and universities at once make such revisions of their undergraduate courses in mathematics and add such courses to the curriculum as are necessary to prepare students in the elements of mechanics, probability, surveying, navigation, and other essentials of military science; and (3) that the graduate schools extend their courses in applied mathematics, such as dynamics, hydrodynamics, elasticity, ballistics, statistics, etc., and that advanced students be urged to become highly qualified in one or more fields of applied mathematics.



SCENES AT THE SEPTEMPER 19 MEETING IN WASHINGTON, D. C., OF THE A.S.M.E. COMMITTEE ON NATIONAL DEFENSE, AND ARMY AND NAVY OFFICIALS

(Left to right in both photographs, those facing camera are H. V. Coes; Lt-Col. M. W. Kresge, U. S. Army; Com. C. E. Braine, U. S. Navy; Col. B. O. Lewis, U. S. Army; Com. L. Wood, U. S. Navy; E. A. Muller, Col. L. D. Booth, U. S. Army; J. L. Walsh, *chairman;* W. C. Dickerman; Capt. A. B. Anderson, representing U. S. Navy on Committee; and Maj. J. L. Holman, U. S. Army.

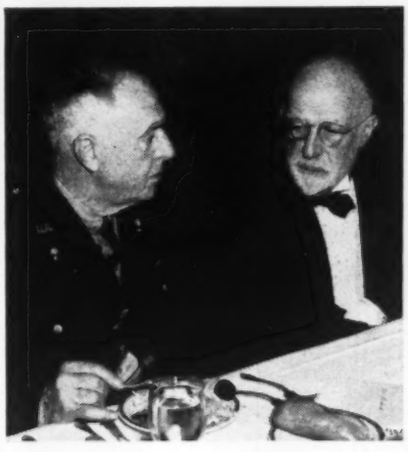
W. H. MCBRYDE, PRESIDENT A.S.M.E., HONORED AT DINNER BY SAN FRANCISCO SECTION, V. F. ESTCOURT, CHAIRMAN OF THE SECTION, AND COL. RALPH ROYCE, WHO SPOKE AT THE MEETING FOLLOWING THE DINNER

San Francisco Section Honors A.S.M.E. President, W. H. McBryde, at Dinner

Meeting Following Dinner Features Talk on National Defense by Col. Ralph Royce, U. S. Army Air Corps

WARREN H. McBRYDE, President of The American Society of Mechanical Engineers, and a resident of San Francisco, Calif., was honored on Oct. 24 at a special dinner tendered to him by 120 members and guests of the San Francisco Section at the Engineers Club. The toastmaster, who was introduced by the Section chairman, V. F. Estcourt, was Dr. William F. Durand, past-president of the Society and honorary member.

Since the dinner was also in the nature of an anniversary celebration, Dr. Durand in his opening remarks covered the various phases of the Society's life since its founding sixty years ago. Following him, Lt-Col. C. F. Weiland recounted the first years of the San Francisco Section which was established 30 years ago.



LT-COL. C. F. WEILAND, DINNER SPEAKER, AND DR. W. F. DURAND, TOASTMASTER

The guest of honor, using as his subject, "A.S.M.E. Today and Tomorrow," dwelt briefly on the founders' objectives, the high standards maintained today, and the future opportunities of the Society in national and engineering affairs. President McBryde showed how the Society depended upon the cooperation and interest of each and every member.

Following the address and the dinner the audience reconvened for the technical meeting which featured a talk on "National Defense —From Blueprints to Gun Fire!" by Col. Ralph Royce, U. S. Army Air Corps, who flew to San Francisco for the occasion from Ft. Douglas, Utah. Of particular interest to the audience was Colonel Royce's experiences as a military observer with the flying forces of the Chinese army. The open discussion which followed lasted until 11 p.m.

Anthracite-Lehigh Valley Meets in Wilkes-Barre and Hazleton

ABOUT 30 members attended the Sept. 27 meeting of the Anthracite-Lehigh Valley Section in Wilkes-Barre, Pa. E. P. Wilson, development engineer, Hazard Wire Rope Co., spoke on the development, manufacture, and uses of wire rope. He traced the development from the metal strands of ancient times through the soft-iron wire used in Germany around 1840 down to the steel-wire strands utilized today. Illustrations of the many applications of wire rope and some of the problems encountered were given.

The Oct. 25 meeting of the Section was held in Hazleton, Pa., with an attendance of 28. George E. Hagemann, chairman of the A.S.M.E. Materials Handling Division, presented a paper on materials handling. He showed motion pictures of applications at the National Cash Register Co., the Warner Gear Works, and Singer Sewing Machine Co.

Atlanta Section Begins Series of Weekly Luncheons for Members

Atlanta Section began a series of weekly luncheons for members on Oct. 7 at the Atlanta Athletic Club. Twenty members and ten guests attended. Everyone had a good time and took part in informal business and technical talks.

Photography Is Subject of Baltimore Meeting, Oct. 28

W. E. Yeaple, Eastman Kodak Co., presented a paper on Oct. 28 before 70 members and guests of the Baltimore Section dealing with "Photography at Work." His paper covered the industrial application of photography and X rays, the use of ultraviolet and infrared rays for photomicrographs, the utilization of infrared in astronomical photography and in photographing the invisible. Pictures taken at $^1/_{200,000}$ sec were shown.

Birmingham Hears C. E. Davies on Subject of National Defense

More than 50 members of Birmingham Section turned out on Oct. 25 to hear an interesting talk on "National Defense" given by C. E. Davies, secretary of the Society. He showed the important part being played by the engineer in the present national-defense program and how the A.S.M.E. is doing its part through its Committee on National Defense and other committees.

Bridgeport Section Reports a "Wow" of a Meeting Oct. 15

"Yankee Ingenuity and Modern Engineering" was the title of a paper presented on Oct. 15 before 80 members and guests of Bridgeport Section by Richard A. North, Farrel-Birmingham Co. He presented chronological data showing how the cotton gin, printing press, textile machinery, and many other important items now in daily use were developed from 1640 until 1940 by New Englanders. The paper was thought-provoking and interesting, states secretary Sniffen, who recommends the speaker to other A.S.M.E. Sections.

Modern Armament Discussed Before 104 Boston Members

Following a dinner, 104 members of Boston Section met on Oct. 10 to hear a paper on "Modern Armament" presented by Lt-Col. Frank M. S. Johnson, U. S. Army, engineer officer of First Corps Area. He compared the merits and uses of various types of tanks and

equipment. His survey of existing phases of the present armament program was very interesting.

Closed Meeting Held by Buffalo Section Oct. 22

More than 100 members and 150 guests of the Buffalo Section were present on Oct. 22 to hear two papers on military aviation presented by Fred Flader and Peter Rossman, Curtiss Aeroplane Division, Curtiss-Wright Corp. At the request of the speakers, no notes were permitted to be taken by the audience. Mr. Flader covered trends in aircraft design, optimum speeds and altitudes, plastic construction, stainless steel, and supersmooth skin surfaces. Mr. Rossman discussed present-day production methods in the aviation industry.

Motion Picture on Beer at Central Illinois

Approximately 50 members and guests of Central Illinois Section gathered on Sept. 20 to see and hear a sound motion picture on the making of beer. Particularly interesting were the many machines used in the process.

Central Indiana Members Go to Penitentiary

The Oct. 4 meeting of the Central Indiana Section was held in Terre Haute, Ind. The first event on the program was a visit to the new Federal penitentiary, open for public inspection on that date. Then the 60 members and guests adjourned to dinner at the Rose Polytechnic Institute dormitory. The meeting which followed featured a paper on "Strip Mining," by Hugh B. Lee, vice-president, Maumee Collieries Co. He discussed the methods employed in prospecting and exploration of sites for strip-mining operations and showed large photographs of the equipment used in the operations of uncovering and removing the coal.

More Than 450 Engineers Attend October Meetings in Chicago

The October program of the Chicago Section was started off on the third with a joint meeting with the local section of the A.I.E.E. and the W.S.E. dealing with the subject of "Registration for Engineers." J. S. Dodds, vice-president of American Engineering Council, and T. G. LeClair led the discussion on the bill which is to be submitted to the Illinois Legislature. The attendance was more than 200.

On Oct. 10, more than 50 members heard a paper by J. Kaye Wood on the subject of "Suspension of High-Temperatur: Piping." He discussed the effect of shifting support forces upon the deflection and stresses of a piping system when temperature changes occur.

Industrial mobilization was the subject of the Oct. 15 meeting and it was ably presented to 160 members by Col. Donald Armstrong, of the Chicago Ordnance District. The complete process of placing industrial orders through the procurement branch working under the Assistant Secretary of War, to the inspection in the plants, and the receipt and distribution of the supplies was described.

AT THE MEETING OF THE A.S.M.E. MID-CONTINENT SECTION OCTOBER 7, 1940

Colorado Has Student and Naval Officer as Speakers

Colorado Section conducted an interesting meeting on Oct. 25 at which the speakers were Stanley Proffitt, student member from the University of Colorado, speaking on "Master's Versus Business Degrees," and Commander C. M. Johnson, U. S. Navy, describing "Our American Navy." Mr. Proffitt presented arguments for and against both the master's and business degrees, pointing out particularly the difficulty students experience in knowing which course to pursue. Commander Johnson showed several motion pictures of the U. S. Navy in action and gave many interesting facts concerning mechanical engineering and battleships, good engineering, finance, production, etc.

Columbus Visits Observatory

The Oct. 28 meeting of the Columbus Section consisted of a visit to the Perkins Observatory, Delaware, Ohio, and a talk on "The Milky Way," by Dr. N. T. Bobrovnikoff. Everyone of the 50 present found the program very interesting.

Green Mountain Holds First Meeting on October 25

The first meeting of the Green Mountain Section for 1940–1941 was held on Oct. 25 in Springfield, Vt. There were about 75 members and guests present to see a motion picture on "The Physics of Metal Cutting." Richard Brown, Henry Prentiss Co., gave a running commentary during the showing of the film. Among those present was Charles Beach a member of the Society for more than 50 years, who came 50 miles to attend the meeting.

Oil-Field Equipment Discussed Before Mid-Continent Section

D. O. Barrett, chief engineer, Gulf Oil Corp., Tulsa, Okla., addressed the Mid-Continent Section on Oct. 7. His paper described "Practical Developments in Oil-Field Equipment." The meeting was attended by more than 180 members and guests. Exhibited during the meeting were several pieces of equipment developed by Mr. Barrett and his associates for the handling of salt water and prevention of corrosion. The discussion that followed included a description of gearboxes and gas engines.

D. O. BARRETT, CHIEF ENGINEER, GULF OIL CORPORATION, TULSA, OKLA., ADDRESSED MID-CONTINENT SECTION OF A.S.M.E. ON OCTOBER 7, 1940

Minnesota Section Holds Meeting With A.S.C.E.

The Minnesota Section of the A.S.M.E. held a joint dinner meeting with the Northwestern Section of the A.S.C.E. in St. Paul, Minn., on Oct. 7. Herbert J. Miller, executive secretary of the Minnesota Resources Commission, spoke on "The Creation of Jobs Through the Use of Our Resources." He pointed out the importance of research to develop new industries in Minnesota and cited many examples of recent industrial trends and developments.

100 Attend Oct. 10 Meeting of Ontario Section

About 100 members and guests of Ontario Section were present on Oct. 10 at the University of Toronto to hear a lecture demonstration given by Richard K. Scales, Ethyl Gasoline Corporation. He discussed recent developments in automobile and aviation gasolines and showed what might be expected in the near future. Relationships between types of fuel available and engine design were indicated.

Dry Kiln Fans Subject of Oregon Meeting

A discussion of the recent research on dry kiln fans, as carried out at Oregon State College by the department of mechanical engineering, was given at the Sept. 27 meeting of Oregon Section by Prof. Arthur D. Hughes.

Piedmont Section Learns About Water Works

At a joint meeting of the Piedmont Section, A.S.M.E., and North Carolina Section, A.S.C.E., in Charlotte, N. C., on Oct. 18, G. S. Rowlins and W. M. Franklin gave a paper on the design and operation of the Charlotte Water Works. They were followed by David Nabo, designing engineer, Duke Power Company, who gave a paper on one of his company's new steam plants.

Philadelphia Hears Talks on Mechanical Equipment for Army

Because the Oct. 22 meeting of the Philadelphia Section was devoted to the subject of "Mechanical Equipment for the Army," only American citizens were permitted to attend. Nevertheless, 425 members and guests came to hear Maj. D. N. Hauseman and Maj. W. S. Broberg, both of the Philadelphia Ordnance District, discuss the latest developments and to partake in the question-and-answer period.

Providence Members Learn Details About Teredos

Teredos, as 80 members and guests of Providence Section were told on Oct. 1 by William Clapp, are tiny marine creatures so fragile that they all but defy human handling but are still capable of destroying great piers and wharves. Mr. Clapp has discovered how this creature's depredations can be prevented.

University Power Plant Subject of Raleigh Meeting

F. B. Turner, superintendent of the new power plant in Chapel Hill, N. C., which furnishes electric power to the town and the University of North Carolina and heat to the University, was the guest speaker at the Oct. 18 meeting of the Raleigh Section. His paper was a description of the plant.

Men and Machines Discussed at Rock River Valley

Rock River Valley Section met on Sept. 19 in Rockford, Ill., and the 72 members and guests present heard a talk on "Men and Machines" given by Mr. Martin, secretary-treasurer, Woodward Governor Co. The paper was based on the methods of selection of men and machines utilized by the speaker's company. After the meeting, an inspection tour of the plant was made.

More Than 150 Attend Schenectady Smoker

More than 150 members and guests of the Schenectady Section attended the annual smoker, held on Oct. 24 at the Edison City Club. After the introduction of the Section officers, the committee in charge of the affair presented several skits and boxing matches. Refreshments consisting of cider, beer, doughnuts, and pretzels were served.

War Equipment Discussed at Toledo Section Meeting

The Oct. 10 meeting of the Toledo Section attended by 83 engineers was on the subject of "Our Progress in the Production of War Equipment" as discussed by Col. H. W. Miller. He reviewed the types of equipment being used today, such as the Garand rifle, the mechanized field artillery, antiaircraft guns, tank construction, and airplanes for bombing and troop-carrying purposes.

Ordnance Engineering Subject of Washington, D. C., Meeting

The development of tanks, antitank guns, and antiaircraft material was discussed at the Oct. 10 meeting of the Washington, D. C., Section before 125 members and guests by Maj. D. J. Crawford, Capt. B. S. Mesick, and R. O. Eliason. Also described were some features of present-day equipment and production problems.

Western Washington Section Has Session on Warships

Commander W. R. Nichols, U. S. Navy, was the guest speaker at the Oct. 15 meeting of the Western Washington Section. He outlined to the 175 members and guests the organization of the Navy Department, and explained the relationship of each branch in the final design of a warship. Interesting discussion followed.

MEMBERS AND GUESTS OF THE A.S.M.E. SAN FRANCISCO SECTION AT THE DINNER IN HONOR OF PRESIDENT W. H. MCBRYDE ON OCTOBER 24. SEE STORY ON PAGE 943

Junior Group Activities

Boston Juniors Publish News Sheet

THE Boston Junior Group presents a new idea for other junior groups in the A.S.M.E., a two-page mimeographed news letter, *Junior Jottings*, which contains among many interesting features a list of names of A.S.M.E. juniors transferred into the Boston Section, a list of new members together with their company affiliations, an outline of the coming season's program, and many personal items, including doings of the Group, the romantic inclinations of some Boston Juniors, and other such human-interest stories. A news letter of this type, reaching every Junior, is expected to lead to greater cooperation and friendship among the members and increased mutual assistance between the members and their Society.

The meeting of Oct. 30, as recorded in *Junior Jottings*, featured a talk by Dr. Hallam L. Movius, Peabody Museum of Archaeology and Ethnology, Harvard University, on the "Problems Relating to the Discovery of Fossil Man in the Old World." Although the title sounds forbidding, it is reported that everyone present at the meeting enjoyed the talk because it gave them an insight into the history of early man.

Personnel Relations Subject of Chicago Junior Meeting

THE Chicago Junior Group held its first meeting of the season on Oct. 22 at the Civic Opera Building. The speaker of the evening, Thomas Wilson, spoke on "Personnel Relations," reviewing the present-day employment situation and its bearing on the national-defense program. He stated that the demand for engineers had more than exhausted the present supply. In appreciation of the fine talk by Mr. Wilson, the 50 Juniors present gave a vote of thanks.

Kansas City Juniors Hold Aeronautics Session

THE Kansas City Junior Group, at its regular meeting on Oct. 8, heard Vernon Altman, Glenn L. Martin Aircraft Corporation, outline the problems involved in producing large quantities of airplanes for the government. He showed how an original order for $19,000,000 was gradually increased until it reached $99,000,000. Of course, every increase brought a change in plans and design. But the aircraft industry is meeting the problem through mass production. For example, last year planes were coming off the Martin production line at the rate of three a day; today that rate has been increased to five a day.

Following Mr. Altman, a technicolor motion picture of the Pacific Northwest and Alaska was shown by Norvin Welch. The pictures proved to be both interesting and educational. There were 27 Juniors present at the meeting.

Detroit Juniors Have Dinner and Auto Plant Inspection Trip

THE Detroit Junior Group started its 1940–1941 season with a dinner followed by an inspection trip through the Chrysler Research Laboratories, Highland Park, Mich., on Oct. 15. To give each Junior plenty of time for asking questions, the inspection groups were kept small in number. There was so much interest shown in the inspection, that the hour was very late when the last group finished its trip.

The November meeting is being arranged by Chairman L. Lentz and Richard Nelden, who plan to have a social gathering, possibly at the Detroit Yacht Club, with some entertainment, including motion pictures.

1940–1941 OFFICERS OF THE A.S.M.E. STUDENT BRANCH AT PURDUE

(Left to right, C. H. Rockwood, secretary-treasurer; G. B. Kirkpatrick, vice-chairman in charge of publicity; T. P. Peppler, chairman; J. E. Gerding, vice-chairman; D. R. Cooley, vice-chairman.)

With the Student Branches

A.S.M.E. Student Day at Annual Meeting Features Session, Luncheon, and Trips

WEDNESDAY, December 4, has been designated as Student Day at the Sixty-First Annual Meeting of The American Society of Mechanical Engineers, which is being held in New York City, Dec. 2–6, 1940. Several hundred student members from all parts of the United States will attend the several events planned for them. The official representative of each Student Branch will be the guest of the "Old Guard Committee" at the Annual Dinner and Honors Night being held that evening.

Following a student business and technical session in the morning, the students and prominent engineers will assemble for the Annual Student Luncheon at which the guests of honor will be Warren H. McBryde, President of the A.S.M.E.; Frank De Pould, winner of the 1940 Charles T. Main Award; G. W. Shepard, Jr., recipient of the 1940 A.S.M.E. Postgraduate Student Award; Edward D. Rowan, recipient of the 1940 A.S.M.E. Undergraduate Student Award; and William A. Hanley, president-elect of the Society and former chairman of the Committee on Relations With Colleges. Huber O. Croft, manager-elect of the A.S.M.E. and present chairman of the Committee, will preside.

In the afternoon, each student member attending the Annual Meeting will be able to participate in one of the regular technical sessions or take part in one of the many interesting inspection trips planned for the afternoon. The committee in charge of the Annual Meeting has already made arrangements with the management of the Power Show, being held at Grand Central Palace during the week of December 2, to admit all A.S.M.E. student members upon the presentation of their membership cards at the gate.

Akron Branch Reports First Meeting

The first scheduled meeting of the AKRON BRANCH was held on Oct. 9 and was attended by 16 members. Prof. Fred S. Griffin, honorary chairman, gave a talk on the history and aims of the A.S.M.E. Plans were made for an inspection trip to the experimental laboratories of the General Electric Co., Cleveland, Ohio, and the Ford Motor Company, Detroit, Mich.

ARKANSAS BRANCH has a good program idea which can be adopted by other branches. At the Oct. 4 meeting, three candidates for membership were required to present technical papers before being accepted. The speakers were Carter, Kunkel, and Tardy. Secretary H. H. Clayton reports that despite the requirement present indications are that the Branch will have more members this year than ever before

BROOKLYN POLY BRANCH (day) had as speaker on Oct. 8, Prof. Edwin F. Church, who talked on the value of joining a professional organization. He stated that it was the aim of the A.S.M.E. and other engineering societies to bring together men with a common interest.

BUCKNELL BRANCH met on Oct. 18 and heard

informal talks by Professors R. L. Anthony and G. M. Kunkel on the advantages of A.S.M.E. membership. The audience then adjourned to the internal-combustion laboratory where refreshments were served and the Diesel engine demonstrated.

British Columbia Branch and War

Because of compulsory military training now in force at the University, members of BRITISH COLUMBIA BRANCH have only Tuesday open for the weekly meeting. It was also announced at the Oct. 4 meeting that the war has made it increasingly difficult to get permission to visit industrial plants. Furthermore, motion-picture films from the United States cannot be obtained because requests must be forwarded through the Foreign Exchange Control Board. It is not expected that any student member will be able to attend the Annual Meeting in New York or the Spring Student Conference because of passport and exchange regulations.

C.C.N.Y. BRANCH members met on Oct. 17 and heard Max Steinberg, division engineer, Consolidated Edison Co. of New York, give a talk on load division in power generation. His paper was augmented by the use of carefully prepared slides and a well-compiled bibliography, copies of which were distributed to members of the audience.

CLARKSON BRANCH held a speaking contest on Oct. 17 at which a cash prize of two dollars was awarded as first prize. The judges were Professors Jess H. Davis and Herbert A. Weiss. Speakers and their papers included: Lloyd Welch, bevel gears; David Allerdice, air conditioning; Alan W. Hogle, gyroscope; and James Storrier, panorama of lubrication. Student members Hogle and Storrier were awarded first prize jointly.

COLORADO STATE BRANCH featured a talk on the development of airplane engines by Wayne Sneddon at its Oct. 21 meeting. After a general discussion, the meeting was adjourned and the members had lunch together in the mechanical-engineering laboratory.

COLORADO BRANCH opened its first meeting of the school year on Oct. 2 with an audience of more than 40 members. Following the appointment of a committee headed by Charles Elzi to make plans for a picnic, a large number of those present joined the student members of the A.S.C.E. chapter in viewing a film on "The Making and Framing of Structural Steel Members."

Colorado Mines on Trip

Members and guests of the COLORADO SCHOOL OF MINES BRANCH got up early on Oct. 26 in order to go to the Denver Union Depot to inspect the Rock Island Railroad's latest streamlined train at 8:15 a.m. However, everyone present felt that the train was well worth the effort.

COOPER UNION BRANCH (day) had a turnout of 46 members at the Oct. 23 meeting during which Arthur Swenson, chairman of the Branch, outlined a program for the coming year. Among the activities listed were presentation of technical papers by members, guest speakers, inspection trips, and a dinner.

550 at Cornell Meeting

The first meeting of the CORNELL BRANCH this year on Oct. 8 was a joint affair with the branches of the A.S.C.E., A.I.E.E., and A.I.Ch.E. Harte Cooke, member A.S.M.E., as presiding officer gave a short introductory talk on the advantages of membership in a national engineering society. He then introduced the chairmen of the four student branches who outlined briefly each group's plans for the coming year. The speaker of the evening was Dean S. C. Hollister, who spoke on "The Factor of Safety," illustrating his paper with examples taken from industry. The Oct. 22 meeting of the CORNELL BRANCH was attended by 125 members and guests who heard a talk on airports and airplanes by Herbert M. Peters, manager of the Ithaca airport.

IOWA STATE BRANCH held its annual "get-together" meeting on Oct. 9. The feature of the evening was the traditional smoking of the Branch's peace pipe. Professor Breakenridge, in full Indian regalia, told a humorous tale of the engineering ability of the early Indian. He then started the peace pipe around the group. Out of the 133 present, 33 signed up as student members after the meeting.

IOWA BRANCH held the Oct. 9 meeting in one of the studios of the new radio building of the school. E. F. Knott, chairman of the Branch, described the atom smasher recently built and installed by the physics department of the University.

A. G. Christie Speaks at Johns Hopkins

The first meeting of the JOHNS HOPKINS BRANCH of this year was held on Oct. 2 and featured as guest speaker Prof. Alexander G. Christie, past-president of the A.S.M.E. He described briefly his activities during the last summer as well as his work in previous summers.

KANSAS BRANCH held its engineering "mixer" on Oct. 17 for the purpose of developing friendships among the faculty, advanced students, and freshmen. At the special luncheon on Oct. 23, the guest of honor was Ernest Hartford, assistant secretary of the A.S.M.E.

Aeronautic Research at Kentucky

Col. James H. Graham, dean of the college of engineering at the University, was the guest speaker of the KENTUCKY BRANCH on Oct. 18. His subject was the new aeronautical-engineering laboratory now under construction. When completed, the laboratory will be the most complete and best equipped in the United States of any college designed exclusively for the testing of aircraft engines. Prof. A. J. Meyer, formerly chief research engineer of Continental Motors Corporation, will have charge of the laboratory.

MICHIGAN BRANCH had more than 100 present at the Branch's membership-rally meeting on Oct. 15. Paul Johnson, chairman, introduced the speakers who included Dean Joseph A. Bursley, Prof. R. S. Hawley, and Prof. E. T. Vincent. They spoke about the reasons for joining the A.S.M.E. Sabin Crocker, vice-chairman of the Branch and chairman of the program committee, outlined the program for the coming year.

MISSOURI SCHOOL OF MINES BRANCH welcomed an old friend at its Oct. 18 meeting. He was none other than Ernest Hartford, assistant secretary of the national society, who praised the members for the fine work they were doing. At the request of the officers, he gave several hints on how to run bigger and better meetings.

Missouri Branch Has Pow-Wow

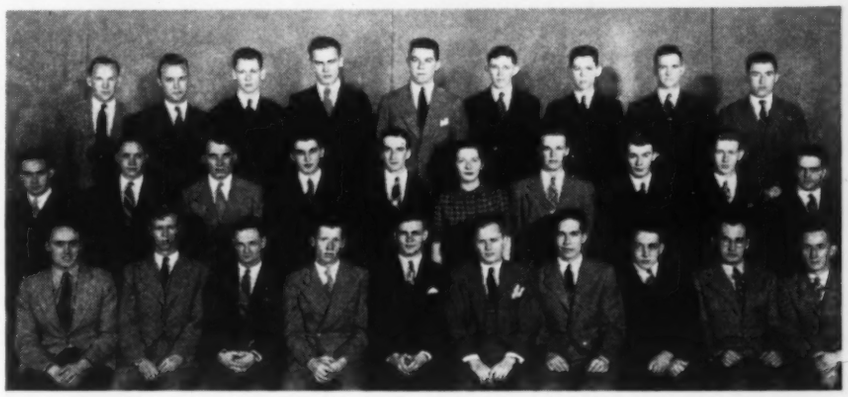
On Sept. 28, 156 members and guests of MISSOURI BRANCH gathered at Rollins Spring for the annual pow-wow. Students engaged the faculty in softball and football games, following which the freshmen and sophomores had a tug of war. As darkness approached, the boys gathered around the cooking fires and were served hot dogs, coffee, and ice cream. The evening's fun was concluded by group singing around a big bonfire.

NEBRASKA BRANCH held a meeting on Oct. 23 and heard a talk by W. H. Ruten, foundry instructor at the University, on "Modern Foundry Production and Methods." Importance of metallurgy in the foundry was stressed and recent improvements in the field mentioned. Mr. Ruten discussed also the opportunities for college graduates in foundry work.

NEW HAMPSHIRE BRANCH made plans on Oct. 11 to have each member present a talk on some technical subject at least once during the coming term. This is designed to insure a profitable meeting each week and to give everyone practice in the vital art of public speaking.

N.Y.U. Holds Aeronautics Smoker

Besides luncheon meetings, N.Y.U. BRANCH (aeronautics) also holds several smokers during the term. At the first smoker on Oct. 30,



STUDENT MEMBERS AT THE UNIVERSITY OF NEW HAMPSHIRE HAD THEIR PICTURE TAKEN BEFORE GRADUATION IN JUNE, 1940

the guest speaker was Captain J. M. Miller, air-transport pilot with Eastern Air Lines. He spoke on general air-line operation and discussed in detail the experimental autogiro mail project which he has directed for the last year.

NORTH CAROLINA STATE BRANCH had a gathering of almost 100 members and prospective members on Oct. 22 to listen to James S. Burch, engineer with the North Carolina Highway Commission, who gave a very interesting paper on the functions and cost of upkeep of public roads. Following the talk, a motion picture, "The Power Within the Assembly of a 1940 Engine," was shown.

NORTH DAKOTA AGRICULTURAL BRANCH members were privileged on Oct. 15 to hear two excellent papers given by fellow members. Glenn Waller spoke on "The Effects of Tetraethyl Lead in Motor Oils," and Everett Hall talked on "Exhaust-Gas Analysis."

Northeastern Has a Class in Terpsichorean Engineering

To supplement the regular engineering courses, NORTHEASTERN BRANCH arranged for the evening of Oct. 18 a special four-hour class in terpsichorean engineering, which was attended by 40 members and 50 guests and ladies. The class schedule included registration, instruction, laboratory practice, selection of "class b.t.u.-ful," quiz period, refueling, and more laboratory practice. Covered in the curriculum were the subjects of the preheater, ferretti fling, zeller zag, stearns stomp, whittaker wobble, bailey bounce, wolowicz waltz, cole slaw, katz klop, hydraulic hop, and condenser curvet. Responsible for the conduct of the class were R. W. Ireland, valve turner; R. Murray, piston pusher; E. Finkle, meter reader; H. D. Bowen, motor turner; N. H. Eckler, steam maker; and W. Skoglund, water boy.

NORTHWESTERN BRANCH had 77 members and guests present at the Oct. 9 meeting. After a short business session, Chairman Warren Rohsenow introduced the speaker, Professor Jennings, who gave a very interesting as well as enlightening paper on "Radiant Heating." After souvenirs were passed out to all those in attendance, a motion picture from General Motors Corp. on "Where Mileage Begins" was shown.

OHIO STATE BRANCH members numbering 106 and three guests were present for the Oct. 11 meeting. Speaker at the session was Lt-Col. Dorst, who had charge of the construction of Treasure Island, site of the 1939–1940 Golden Gate International Exposition. He described the methods used in creating the island, explaining in detail the mechanical features of the vast undertaking.

OKLAHOMA A.&M. BRANCH has made arrangements for its members to use the M.E. laboratory and equipment in the preparation of papers for the various A.S.M.E. national prizes, according to an announcement made at the Oct. 14 meeting. Speakers at this meeting were Robert D. Brown, talking on "Oil-Well Acidation," M. Le Fever, on "Welding Oil-Well Casings," and Fred Fennema, on "Use of Plastics in Mass Production of Aircraft."

Oklahoma Holds Musicale

The first meeting of OKLAHOMA BRANCH for 1940–1941, held on Sept. 26, featured for the edification of 55 members and 20 guests the following program: Two accordion solos by Miss Rosemary Heatly, two vocal solos by Miss Juanita Rice, who was accompanied on the piano by her sister, Miss Floie Rice, and several selections by the Boomer orchestra. The next meeting, held on Oct. 10 and attended by 75 members and 10 guests, included motion pictures on the life of Dr. George Carver, basketball technique, and golf points, and an original research paper by student members Wendell Ford and Bernard Jones on "The Effects of Octane Rating on Engine Performance and Characteristics."

PENNSYLVANIA STATE BRANCH started the year off with an engineering "mixer" on Oct. 8. More than 200 members and guests heard Dean H. P. Hammond, Prof. H. A. Everett, and Prof. F. C. Stewart describe the reasons why engineering colleges and engineering societies were necessary. The meeting was ended with serving cider and pretzels and the receipt of 53 applications for membership.

PITTSBURGH BRANCH held a meeting on Oct. 10 at which Louis C. Endsley gave an interesting and amusing talk on "The Subway System in New York City."

PURDUE BRANCH had almost 100 members and guests present at the Oct. 17 meeting which was devoted to the showing of the sound film "Flow," supplied through the courtesy of the Crane Company.

Alumnus Speaks at R.P.I.

RENSSELAER POLY BRANCH members met for the first this year on Oct. 2. The speaker of the evening was Stanley Taylor, a graduate of the class of 1911 and an engineer with the Rensselaer Valve Co. He described the problems in designing and installing valves in dams and other such large works.

RHODE ISLAND STATE BRANCH officers arranged a meeting on Oct. 24 in keeping with the times. Feeling that many of the members would eventually be called into the army, the program committee secured Lt-Col. Frank U. Greer as the guest speaker. His subject was "The Duties of Engineers in the U. S. Army."

RICE BRANCH held a session on Oct. 2 at which the speaker was H. F. Moller, member A.S.M.E., and plant engineer, Reed Roller Bit Co. The title of Mr. Moller's talk was, "It's Fun to Be an Engineer."

SOUTH DAKOTA STATE BRANCH members numbering 43 attended the meeting of Oct. 2. Following a short business session, motion pictures covering the subjects of the New York World's Fair, U. S. Submarine School, and Diesel-engined locomotives were shown.

Stanford Welcomes President McBryde

Following a dinner on Oct. 22, a meeting was held by STANFORD BRANCH at which the guest speaker was Warren H. McBryde, President of the A.S.M.E. His talk was on "What Is Engineering?" and proved to be very interesting to all those present. Refreshments were served after the meeting and each student member had an opportunity to meet Mr. McBryde.

TENNESSEE BRANCH began the year right by having a student member as speaker at the first meeting on Sept. 26. W. F. Hamlin presented a paper on "Versatility of Phenol-formaldehyde Plastics," which he illustrated with plastic objects produced by the school's experimental station. The technical activities of the A.S.M.E.—design codes, standards, and research—were covered in another paper by Prof. R. W. Morton, honorary chairman of the Branch.

TEXAS A.&M. BRANCH had more than 100 members present for the Oct. 8 meeting to hear a talk by H. L. Hall, United Aircraft Co., on the production of aircraft parts and the opportunities for mechanical-engineering graduates in the field. The program was concluded with a student paper by Mac McCullar, who described the various reasons why metals fail.

The Oct. 17 meeting of TUFTS BRANCH was devoted to a talk on "What the Young Engineer Faces in Industry," given by William Sage, division of industrial cooperation at Massachusetts Institute of Technology. Mr. Sage discussed the fields of research, sales, planning, development, and production engineering.

VILLANOVA BRANCH issued invitations on Oct. 14 to the A.S.M.E. student members at PENNSYLVANIA, DREXEL, DELAWARE, and SWARTHMORE to attend a smoker on Nov. 14.

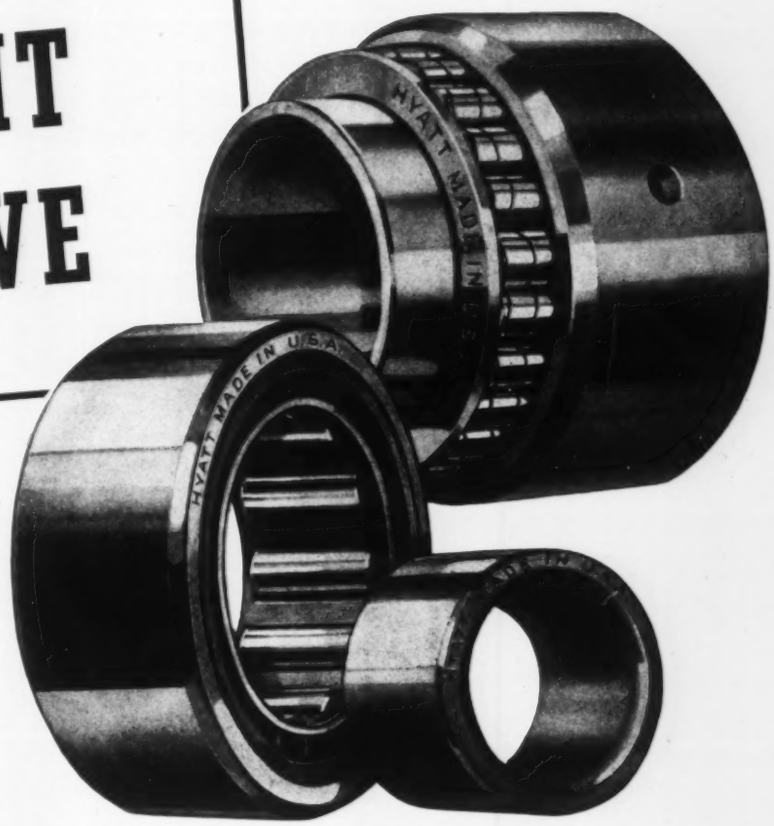
GEORGE WASHINGTON BRANCH had a "mixer" meeting for old and prospective members in cooperation with the other engineering societies on Oct. 2. More than 250 students were present. All freshmen were required to

(*A.S.M.E. News continued on page 940*)

A.S.M.E. STUDENT BRANCH OF NORTHEASTERN UNIVERSITY HOLD DANCE IN MECHANICAL ENGINEERING LABORATORY

(Prof. Joseph W. Zeller, chairman of the mechanical engineering department, and Mrs. Zeller are at the right of the first row.)

WHERE ONLY THE FIT SURVIVE



HYATT WOUND ROLLER TYPE AND HY-LOAD SOLID ROLLER BEARINGS shown opposite. Inherent design advantages, uniformity and accuracy, along with their capacity for heavy loads, account for the widespread application of these better bearings.

UNDER HEAVY LOADS day in and day out . . . Hyatts run smoothly and enduringly! No matter what the application—Hyatts keep equipment working . . . survive where others fail! Everywhere Hyatt Roller Bearings are proving their mettle and are assuring dependable operation and longer equipment life! Let us give you further facts about these better bearings for the machines you build or buy! Hyatt Bearings Division, General Motors Sales Corporation, Harrison, New Jersey; Detroit, Chicago, Pittsburgh and San Francisco.

HYATT *Roller* BEARINGS

introduce themselves to the audience over the public-address system. This was followed by a skit which caricatured some of the best-liked members of the faculty. The traditional doughnuts and cider were served.

WASHINGTON BRANCH turned over the job of welcoming new members to the first meeting on Oct. 10 to Prof. E. O. Eastwood, who stated that he would be willing to wager anything except real money that all those joining would be at the top of the class at graduation.

Wisconsin Nearing 100 Mark

It was announced at the Oct. 17 meeting of WISCONSIN BRANCH that the membership of 95 had already passed last year's high mark and it would not be very long before the 100 mark would be passed this year. Credit for this wonderful achievement is due Clyde Kaiser, chairman of the membership committee, and Edward Katz, chairman of the program committee, for their part in making this record possible. After the brief business session, O. P. Campbell, Sinclair Refining Company, spoke on fuel oils and showed colored motion pictures illustrating the different kinds of flames found in furnaces which use fuel oil.

Ed. W. Burbank Better

FRIENDS of Ed. W. Burbank, former member of the Council, A.S.M.E., will be glad to learn that on a recent trip to Texas, Ernest Hartford, assistant secretary A.S.M.E., found Mr. Burbank in improved health although still unable to carry on his customary business tasks. Mr. Burbank expressed lively interest in A.S.M.E. affairs and inquired about friends and acquaintances from whom he has been cut off as a result of his illness. Letters will reach him at 3904 Miramar Ave., Highland Park, Dallas, Texas.

A.S.M.E. Local Sections

Coming Meetings

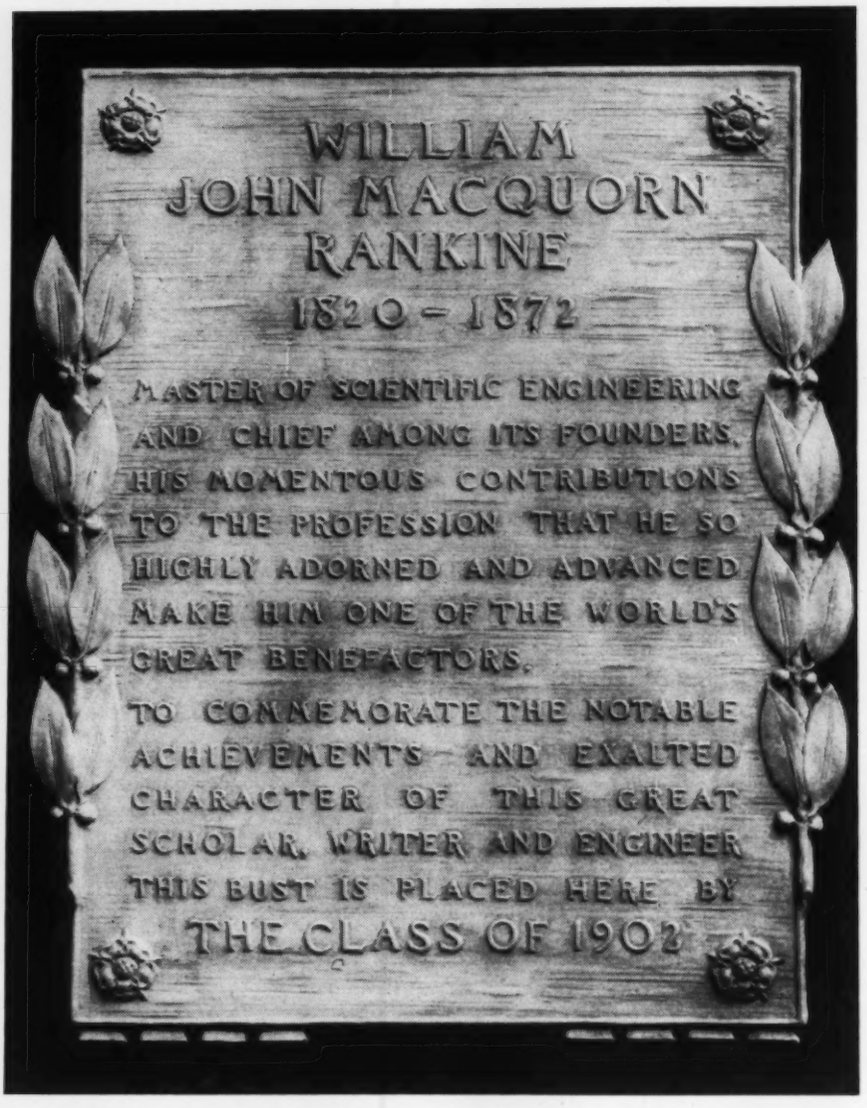
Akron-Canton. December 6. O'Neils Tea Room, Akron, Ohio, at 6:30 p.m. Subject: "Industrial Mobilization," by Major H. M. Reedall, U. S. Army, executive officer of the Cleveland Ordnance District.

Boston. December 12. Walker Memorial Building, The Massachusetts Institute of Technology; dinner at 6:30 p.m.; meeting at 7:30 p.m. Subject: "Montaup Station's High-Pressure Steam Generator," by F. H. Rosencrants, vice-president of the Combustion Engineering Corporation, New York, N. Y.

Chicago. December 3. Classroom on thirty-sixth floor, Civic Opera Building, Chicago, Ill. This meeting will be sponsored by the Management Division of the Section. Subject: "Bonus Plan."

December 11. Meeting to be held in the theater on the thirty-sixth floor, Civic Opera Building, Chicago, Ill. This meeting will be sponsored by the Power and Fuels Divisions of the Section. Subject: "Industrial Power Plants."

Detroit. The December meeting will be a joint one with the Engineering Society of Detroit. Details will be sent to Section members.



TABLET ON THE PEDESTAL OF THE BUST OF WILLIAM JOHN MACQUORN RANKINE, BY THE SCULPTOR BRYANT BAKER, UNVEILED AT THE VIRGINIA POLYTECHNIC INSTITUTE, GIFT OF THE CLASS OF 1902. SEE ALSO PAGES 856 AND 857

Mid-Continent. December 9. Michaels Cafeteria at 6:15 p.m., starting with dinner. Subject: "High-Pressure Absorption Recycling Plants," by E. E. DeBack, general superintendent, Corpus Christi Corporation. E. S. Burnett, senior engineer of the U. S. Bureau of Mines, will also talk.

Ontario. December 12. Hart House, University of Toronto; dinner at 6:30 p.m.; meeting at 7:30 p.m. (Daylight Saving Time). This meeting will be combined with the Seniors and Juniors, held under the auspices of the Junior Group who are responsible for the meeting. Subject: "Aircraft-Engine Testing and Development," by M. S. Kuhring, National Research Council, Ottawa, Canada.

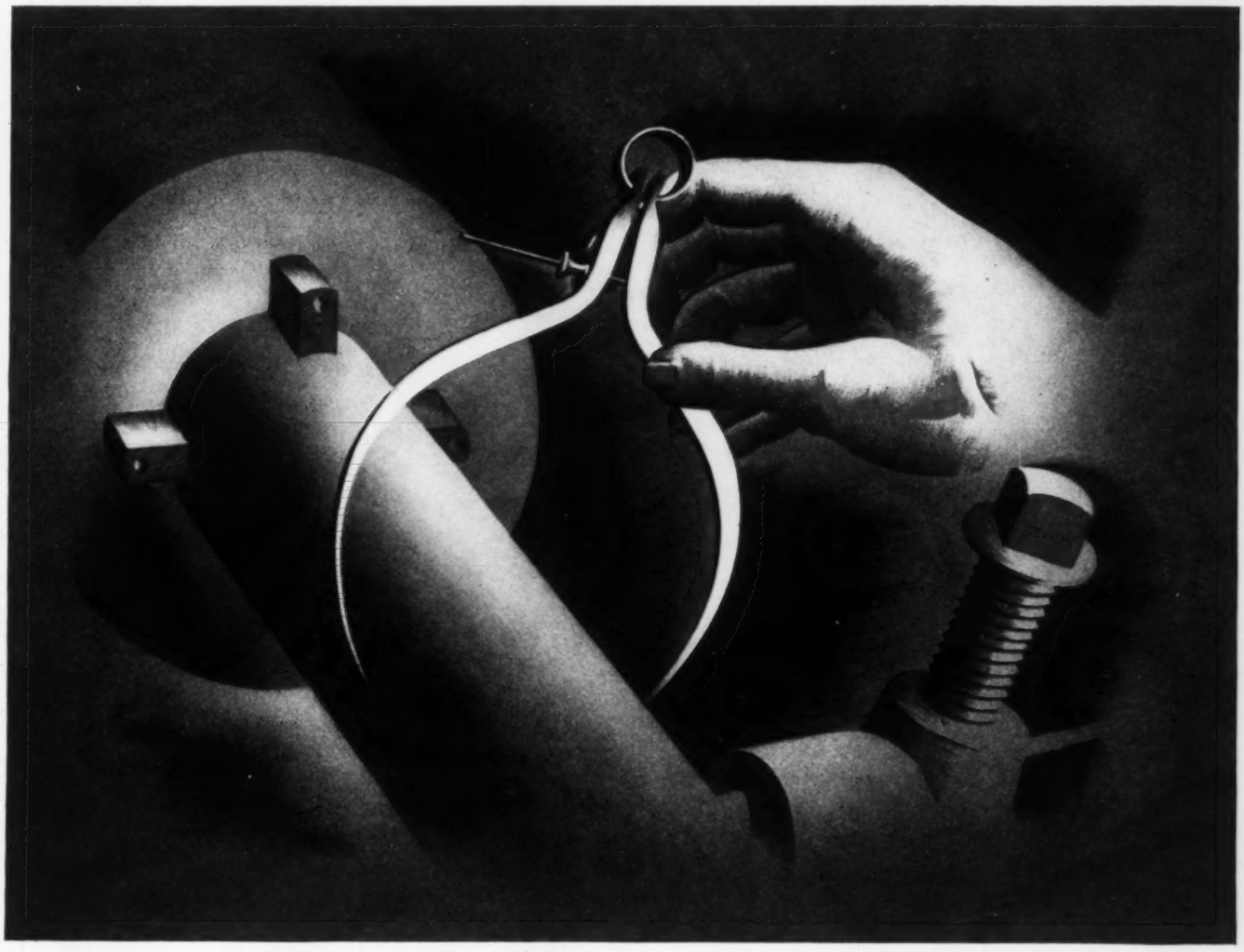
Philadelphia. December 10. Franklin Institute at 7:30 p.m. Dinner at the Engineers Club will precede meeting. Subjects: "Cutting Materials," by Malcolm F. Judkins, chief engineer, Firthite Division, Firth-Sterling Steel Co., McKeesport, Pa., and "Cutting Lubricants," by W. H. Oldacre, manager of D. A. Stuart Oil Co., Chicago, Ill.

Pittsburgh. December 12. William Penn Hotel at 8:00 p.m. Meeting with the Engineers Society of Western Pennsylvania. Subject: "Factors in Evaluation of Bids or Proposals," by Frank Clark, Stone & Webster Corp.

St. Louis. December 20. Candlelight House at 6:30 p.m. Dinner meeting. Subject: "The Present Methods of Rubber Reclamation," by Gilbert K. Trimble, vice-president of the Midwest Rubber Reclaiming Company.

Washington, D. C. December 12. Potomac Electric Power Company Auditorium. Dinner at 6:30 p.m.; meeting at 8:00 p.m. Subject: "Applied Mechanics of Materials and Structures at the National Bureau of Standards." C. S. Acheson will talk on "Mechanical Properties of Materials;" W. R. Osgood on "Elasticity and Plasticity;" and W. Ramberg on "Dynamics."

(*A.S.M.E. News continued on page 942*)



WHEN PRECISION GUARDS PRECISION

It is an old saying that "it's a poor workman who blames his tools". But shop foremen know that even the best operator cannot turn out precise and well finished work on a lathe with worn or faulty headstock gears.

To make sure of maintained accuracy at this vital spot, a well-known lathe maker has standardized on carburized Nickel-Molybdenum steels — using SAE 4815 for drive gears and SAE 4615 for the transmission gears.

These two Molybdenum steels, in addition to having the requisite core strength and toughness, carburize to 55-60 Rockwell "C" with minimum distortion. Consequently proper initial adjustment is simple and freedom from trouble due to worn teeth is assured for an extended service period. Thus precision guards precision for years.

Rechecking your own specifications may disclose opportunities for increasing serviceability of the product by a change in materials. You will find our book, "Molybdenum in Steel", helpful. It is sent free on request.

PRODUCERS OF MOLYBDENUM BRIQUETTES, FERRO-MOLYBDENUM, AND CALCIUM MOLYBDATE

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MOLY

Men and Positions Available

Send inquiries to New York Office of Engineering Societies Personnel Service, Inc.

29 W. 39th St. New York, N. Y.	211 West Wacker Drive Chicago, Ill.	57 Post Street San Francisco, Calif.	Hotel Statler Detroit, Mich.

MEN AVAILABLE[1]

MECHANICAL ENGINEER, 22, single, B.S. 1940. Machine-shop experience. Interested in tool and die design or sales engineering. Willing to locate anywhere in United States. Me-561.

GRADUATE ENGINEER, 39. Fifteen years of electromechanical machine design, industrial-plant layout, design and supervision of construction of production equipment, heating, ventilating, refrigerating, air conditioning, electric power. Metropolitan New York preferred. Me-562.

MECHANICAL ENGINEER, 29, graduate, married. Five years' experience in estimates, cost, and specification records. Two years layout drafting. Now employed. Desires production-control, cost, or development work with active future. Me-563.

MECHANICAL ENGINEER, B.S., recent graduate, 22, single, ambitious. Desires placement as trainee on test work or in power-generation field. Will travel. Me-564.

MECHANICAL ENGINEER, 23, single, Stevens 1938. Eight months of shop, inspection, and assembly work. One year drafting. Now employed. Desires development, production, or maintenance work. Me-565.

GRADUATE MECHANICAL ENGINEER, 26, single. Four years' general experience, one year with metal-container manufacturing company; familiar with costs, spoilage, production and efficiency control, personnel administration, correspondence, construction supervision. Me-566.

MANUFACTURING-PLANT MANAGER OR SUPERINTENDENT, organizer, coordinator, thoroughly conversant all plant activities, controls for materials, production, and costs. Background of industrial engineering experiences in mechanical- and electrical-products plants and in process industries. Me-567.

MECHANICAL ENGINEER, 35. Thirteen years' experience covering construction, chemical-plant operation and maintenance, design, manufacturing, sales, valves, metering and control apparatus. Now employed, California. Desires contact, interests requiring able conscientious man. Me-568.

ENGINEERING ASSISTANT. Compressed air, pumps, motors-sales experience; accountant; tax expert; middle-aged; energetic type. New York or Northwest. Me-569.

POWER ENGINEER, Stevens. Fifteen years' experience operation, maintenance, and design steam power plants. Excellent record in cost reduction through improvements in operation and maintenance. Continuously employed. N. Y. license. Location, East or South. Me-570.

WOOD TECHNOLOGIST, B.S., M.S., single, 27. Two years with woodworking plant, 160 employees; trouble-shooting, inspection, specifications, waste studies, research with adhesives, veneers, laminations, coloring, bending. Production, research, sales employment. Me-571.

SALES ENGINEER, experienced in combustion and particularly utilization of gas in industrial heating operations. Desires sales agency for product salable to industrial plants in New York and surrounding territory. Me-572.

RESEARCH AND DEVELOPMENT ENGINEER, M.E., licensed, married. Creative ability, broad practical experience as machinist, instructor in machine work, chief engineer large water-wheel manufacturer, consultant hydroelectric power development, domestic stokers, etc. Metropolitan area. Me-573.

[1] All men listed hold some form of A.S.M.E. membership.

POSITIONS AVAILABLE

PLANT SUPERINTENDENT for company manufacturing novelties for cosmetic trade, such as lipstick, vanity, and rouge cases, from the stamping of raw material to plating, polishing, lacquering, enameling, and assembling. Metal-stamping experience essential. Company employs 300 people. Salary open. New England. Y-6634.

METHODS ENGINEER, 40–45, graduate mechanical. Must have diversified experience in several well-organized industrial enterprises. Must have thorough knowledge of efficient plant layout, machine tools, materials-handling equipment, and the coordinating of men, materials, and facilities with program of production requirements. Must possess knowledge of costs to introduce and effect economies by improved manufacturing methods. Must have no objection to traveling. New York, N. Y. Y-6660.

PROCEDURE ENGINEER, 40–45, business-administration graduate. Man must possess diversified experience of systems work in at least several well-organized industrial enterprises, to determine most efficient and economical procedure of handling given transaction or controlling activities of business. Position requires thorough knowledge of systems used for various purposes in industrial enterprise together with thorough knowledge of details of procedure. Must have no objection to traveling. New York, N. Y. Y-6661.

SALES ENGINEER, 28–40, for outside territorial supervision sales force, contacting and selling major accounts. Must have demonstrated qualifications in creative merchandising and executive sales management and engineering (mechanical or electrical or both), education and experience required. Headquarters, Middle West. Y-6672C.

MAINTENANCE ENGINEER, graduate mechanical or electrical engineer for general maintenance of group of industrial buildings. Should have considerable electrical training and should be cost-minded. Salary, $250–$300 month. New York, N. Y. Y-6673.

DESIGNERS experienced in layout of heavy machinery interested in Diesel-engine design. Salary, about $200 month. Middle West. Y-6674C.

MECHANICAL ENGINEER to act as assistant in research laboratory for developing heating specialties. Recent mechanical-engineering graduate with leaning toward physics and mathematics. Previous experience not necessary. East. Y-6694.

CHIEF DRAFTSMAN, 35–50, experienced in combustion engineering, particularly in layout of industrial furnaces, waste-heat recovery equipment, etc. Salary, $300–$400 a month. New York, N. Y. Y-6713.

SUPERINTENDENT for boiler and hoisting-engine shop. Must be man of practical experience with ability to handle men and get results. Pennsylvania. Y-6725.

GRADUATE MECHANICAL ENGINEER, about 30, with some previous experience, to act as assistant to plant superintendent in matters involving maintenance and construction in chemical-manufacturing plant. Work will consist of scheduling and supervision of maintenance crews; also some layout work on new projects. Salary open, depending upon experience. Location, New Jersey. Y-6745.

MECHANICAL ENGINEER, 30–45, experienced in setting up standards for machine operations. Must be able to take new drawing and set up standards system. Salary, $60 week. Location, northern New Jersey. Y-6756.

RESEARCH ENGINEER, graduate mechanical, not over 48, who has thorough knowledge of thermodynamics and higher mathematics, to work in research department of nationally known manufacturer. The applicant should have had from one to five years' practical experience in steam and Diesel-engine manufacture or design and possess analytical mind. Salary, $200–$300 a month. East. Y-6765.

CHIEF DRAFTSMAN, 30–45, graduate engineer, capable of supervising drafting room, including machine and tool and die designers; also to supervise engineering estimates for cost estimating. Salary, from $300 month. Ohio. Y-6770D.

GRADUATE ENGINEER with some experience and actual accomplishments in analyzing and improving methods of manufacture, to represent manufacturer in conferences for training of shop foremen. Applicant must have ability to get along with people and faculty of presenting ideas to groups of workers. South. Y-6772.

PRODUCTION SUPERINTENDENT, 30–45, for an upstate New York manufacturer producing mechanical and electrical devices in high volume to close tolerances; 250 employees. Applicant must be thoroughly experienced and have good mechanical and executive background. Salary, about $75 week. New York State. Y-6786.

GRADUATE ENGINEERS, civil or mechanical, 4 to 10 years out, with some experience involving structural design. Men will be placed in shop to become familiar with shop practice and at same time will be given intensive training under company engineers and outside lecturers in aerodynamics, etc. After intensive-

(*A.S.M.E. News continued on page 944*)

To Engineers Who Have Time Only for Facts

Here's One to Help You in the Purchase of Life Insurance. Year in and year out, approximately one-half of The Northwestern Mutual's new business comes from previous policyholders. This proportion of policyholders who "come back for more" is, we believe, unsurpassed in this business. It indicates that the better a man knows The Northwestern Mutual, knows the low cost of its protection, knows the many advantages of its policy contract, the surer he is to choose this company.

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...A Northwestern Mutual Agent has many other plain facts of interest to the discerning buyer. Talk to him.

training period will go into engineering department. Salary, for trainees, about $30 week. East. Y-6792.

DESIGN ENGINEER, B.S. and M.S. in mechanical and chemical engineering with good grounding in fundamentals of fluid flow, heat transfer, strength of materials (pressure vessel and piping), materials handling, evaporation and distillation, instrumentation, and one or more of the following: drying, refrigeration, process air conditioning, filtration, classification (sifters, separators, etc.), grinding (pulverizing), pump and fan engineering. Must have 3 to 5 years' experience in chemical or process-industry engineering and/or development work. Should have at least one year in responsible charge of process and/or plant-layout studies, drafting, design, or equipment selection. Salary open. New Jersey. Y-6802.

ENGINEER several years out of college, with some good production experience, to assist superintendent of factory manufacturing thermostatic-control devices. East. Y-6811.

FACTORY SUPERINTENDENT, not over 45, graduate mechanical engineer, experienced in interchangeable-parts manufacturing. High degree precision on small parts necessary. Must know modern production methods and have handled both male and female help. Company employs 700–800 workers; manufactures aviation spark plugs. Salary open. New York, N. Y. Y-6812.

MAINTENANCE ENGINEER OR SUPERVISOR, about 30, mechanical or chemical-engineering graduate. Must have several years' experience chemical-plant maintenance. Salary, $2700–$3600 a year. Pennsylvania. Y-6818.

GRADUATE MECHANICAL ENGINEER, young, to act as assistant to head of small laboratory. Will be required to run tests on small mechanical equipment, inks, papers, glues, etc. Should have taken courses in organic chemistry, electricity, and physics; possess analytical mind. Salary open. Connecticut. Y-6836.

MECHANICAL ENGINEER with shop experience and good background in mass production as assistant chief engineer. Must prove his particular experience and ability to have earned in excess of $7500 yearly. Excellent opportunity. Apply by letter giving full details and enclosing photo. New Jersey. Y-6846.

Candidates for Membership and Transfer in the A.S.M.E.

THE application of each of the candidates listed below is to be voted on after December 26, 1940, provided no objection thereto is made before that date, and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the secretary of The American Society of Mechanical Engineers immediately.

KEY TO ABBREVIATIONS

Re = Re-election; Rt = Reinstatement; Rt & T = Reinstatement and transfer to Member.

NEW APPLICATIONS

For Member, Associate, or Junior

ANTONY, CHAS., Schenectady, N. Y.
APPLEY, LAWRENCE A., New York, N. Y.
BITTENBENDER, ROBT. P., Oakland, Calif. (Re)
BLISS, DONALD S., Rochester, N. Y.
BROOKS, C. P., Cleveland, Ohio
BROWN, ROBT. V., Cleveland, Ohio
BRUBACK, T. M., Gary, Ind. (Rt)
BUTTERWORTH, J. G., Evanston, Ill. (Rt & T)
CABASSA, HIRAM D., Rio Piedras, P. R.
CASSON, KENNETH H., Rockford, Ill. (Rt)
CHANDLER, WM. C., Brooklyn, N. Y.
CHILTON, THOS. H., Wilmington, Del.
DONOVAN, WM. J., Bloomfield, N. J.
ELMSLEY, C. M. R., Esquimalt, B. C., Can.
ENGELS, E. O., Saginaw, Mich.
FELLOWS, J. R., Urbana, Ill.
FENNO, GEO. F., Philadelphia, Pa.
FINNEY, BURNHAM, Scarsdale, N. Y.
FRIED, ROBT., Brooklyn, N. Y.
GAREY, ROBT. B., San Francisco, Calif.
GOE, JACK H., Bremerton, Wash. (Re)
GOGLIA, M. J., Urbana, Ill. (Rt)
GUNKEL, ROBT. E., Brooklyn, N. Y.
HANSEN, VIGGO, Upper Darby, Pa.
HEROLD, RICHARD, New York, N. Y.
HUEY, CLAUDE L., Atlanta, Ga.
JOHNSON, NATHAN C., Englewood, N. J. (Rt)
JUDSON, WM. H., Philadelphia, Pa.
KIRCHNER, CARL O., Carthage, Mo.
MCEACHERN, JOE A., Balboa Heights, C. Z.
MCKENNA, PHILIP M., Latrobe, Pa.
MCNAIR, FRANKLIN C., Oak Park, Ill.
MEHRINGER, FRANK J., Dorchester, Mass.
MICHELSEN, H. H., New York, N. Y.
NEWHOUSE, CHAS., Detroit, Mich.
RAY, WM. R., Columbus, Ohio
REED, HOMER C., Hermosa Beach, Calif.
REID, DONALD G., Chicago, Ill.
RHODES, T. J., Cincinnati, Ohio
RUTISHAUSER, HANS, Springfield, Ohio
SANDERSON, VICTOR L., Philadelphia, Pa. (Rt)
SAWYER, JAS. G., Normandy, Mo. (Re)
SCHWARZ, FREDK. W., Philadelphia, Pa.
SHENK, ROBT. H., Erie, Pa.
STEVENS, ROBT. H., JR., Lansdowne, Pa.
SUMPTER, LYNN H., Ann Arbor, Mich.
TAYLOR, E. HALL, Chicago, Ill.
THORSON, WILBUR R., Muscatine, Iowa
TICHVINSKY, LEONID M., Annapolis, Md.
TRAVILLA, JAS. C., JR., Philadelphia, Pa.
TURNER, E. ARCHER, Erie, Pa.
USTIN, PETER K., San Francisco, Calif.
WAINWRIGHT, ARTHUR M., New York, N. Y.
WAREHAM, R. S., New York, N. Y.
WEBB, C. C., Wheeling, W. Va.
WELHART, CHAS., Alton, Ill.
WHITESIDE, VICTOR, Hutchinson, Kans. (Rt & T)
WILEY, FRED E., Hartford, Conn.
WILSON, CHAS. E., Scarsdale, N. Y.
WOODWARD, ALAN A., Denver, Colo.

CHANGE OF GRADING

Transfers to Fellow

FERGUSON, HARDY S., New York, N. Y.
HOBBS, J. C., Painesville, Ohio
MOLÉ, HARVEY E., Summit, N. J
RADFORD, GEO. S., New Canaan, Conn.

Transfers to Member

HASELBERGER, RAY, Akron, Ohio
HURT, R. M., Guayaquil, Ecuador, S. A.
JAPIKSE, BERTRAND, Reiffton, Pa.
JAREMA, JOHN D., Ithaca, N. Y.
KROON, R. P., Swarthmore, Pa.
PERRY, STEWART S., Boston, Mass.
PRIAN, VASILY D., Cleveland, Ohio
SACK, MELVIN, Louisville, Ky.
SALMA, E. A., New York, N. Y.
SMITH, FRANCIS C., Atlanta, Ga.
STAPFER, RUDOLF D., Philadelphia, Pa.
VOPAT, WM. A., Malverne, L. I., N. Y.
WEBER, ALBERT M., Wenonah, N. J.
WENZEL, ALFRED C., Chicago, Ill.
WILSON, CHAS. D., Milwaukee, Wis.
WILSON, MARSHALL A., Springfield, Ill.
YOUNG, P. J., JR., Hamburg, N. Y.

A.S.M.E. Transactions for November, 1940

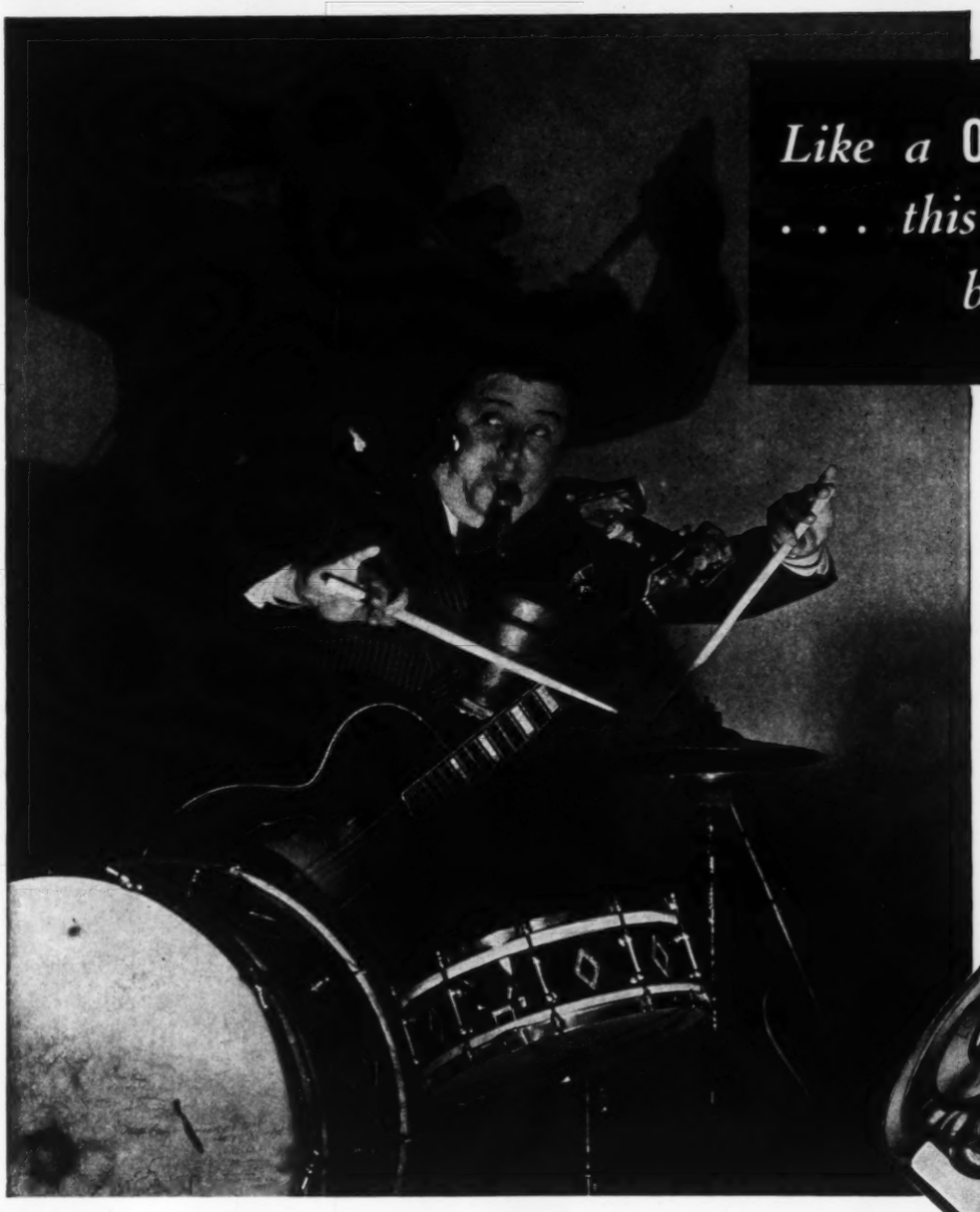
THE November, 1940, issue of the Transactions of the A.S.M.E. contains:

Purchase and Use of Fuel, by E. W. Stone
Salt-Velocity Measurements at Low Velocities in Pipes, by L. J. Hooper
Field Checks of the Salt-Velocity Method, by O. H. Dodkin
The Viscosity of Superheated Steam, by G. A. Hawkins, H. L. Solberg, and A. A. Potter
Steam-Turbine Blading, by R. C. Allen
Discussion of Attack on Steel in High-Capacity Boilers as a Result of Overheating Due to Steam Blanketing, by E. P. Partridge and R. E. Hall
Determination of the Purity of Steam by Gravimetric and Spectrographic Methods, by M. C. Schwartz, W. B. Gurney, and T. E. Crossan
Determination of Ammonia in Condensed Steam, by M. C. Schwartz, W. B. Gurney, and T. E. Crossan
Determination of Purity of Steam by the Electrolytic-Conductivity Method, by W. B. Gurney, M. C. Schwartz, and T. E. Crossan

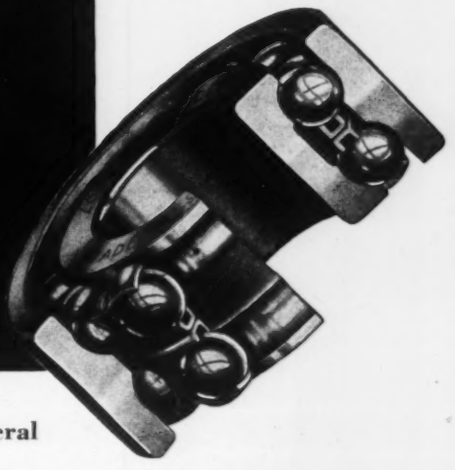
Necrology

THE deaths of the following members have recently been reported to the office of the Society:

GOOD, ROBERT H., October 13, 1940
LEWIS, FRANK S., August 2, 1940
LIPPS, HENRY, JR., October 11, 1940
MCCUNE, CHARLES A., October 14, 1940
ROTTER, MAX, October 6, 1940
SCHARNBERG, HERMAN J. B., October 22, 1940
SHEPARD, F. S., October 10, 1940
WOOD, DENNISTOUN, October 9, 1940



Like a **ONE MAN BAND**
. . . this multi-purpose bearing



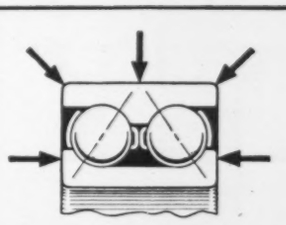
● **The New Departure Double Row bearing is an *expert* at doing several jobs *well*—at the same time.**

It resists radial and thrust loads in *any combination*, with thrust in either direction or reversing . . . provides extremely rigid support under pure radial loads.

It resists misalignment so positively, that in many cases it may be used alone, without need for a second or supporting bearing.

It is a compact, internally preloaded *unit*, applicable in numerous instances *without* need for shaft threads or locknuts.

Here is a truly versatile bearing. Use it to simplify your design. Let it help to save you money and build a better product. 2941



TWO JOBS—ONE BEARING

Big advantages in economy of manufacture and machine performance result from the use of the Angular Contact Double Row ball bearing *which was originated by New Departure* to resist both radial and thrust loads.

Today automobiles, trucks, tractors and machinery of many kinds depend upon bearings developed by New Departure from this original dual purpose "new departure."

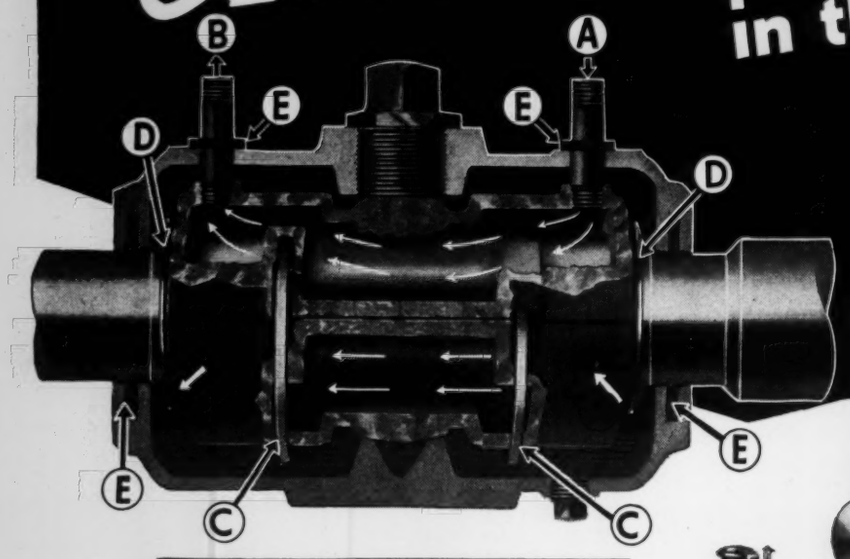
NEW DEPARTURE

THE FORGED STEEL BEARING

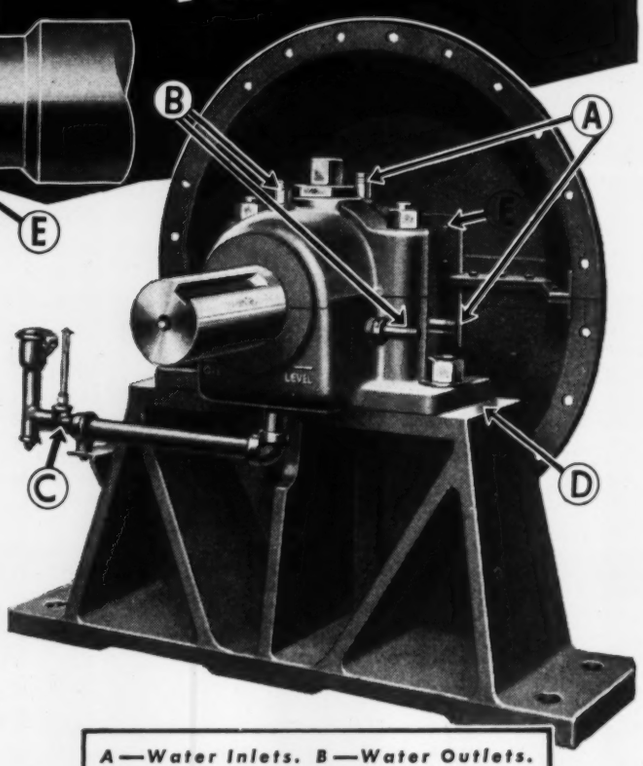
NEW DEPARTURE - DIVISION OF GENERAL MOTORS - BRISTOL, CONNECTICUT - DETROIT - CHICAGO

MECHANICAL ENGINEERING, December, 1940, Vol. 62, No. 12. Published monthly by The American Society of Mechanical Engineers, at 20th and Northampton Sts., Easton, Pa. Editorial and Advertising departments, 29 W. 39th St., New York, N. Y. Price 60c a copy, $5.00 a year; to members and affiliates, 50c a copy, $4.00 a year. Postage to Canada, 75c additional, to foreign countries $1.50 additional. Entered as second-class matter December 21, 1920, at the Post Office at Easton, Pa., under the act of March 3, 1879. Member of the Audit Bureau of Circulations.

Another Reason Why CLARAGE is Ace-High in this Toughest of ALL Fan Services



A—Water Inlets. B—Water Outlets. C—Oil Rings. D—Thrust Collars (forged, turned and ground); integral part of shaft. E—Seals prevent dust leakage into bearing.



A—Water Inlets. B—Water Outlets. C—Oil Filler Cup and Pipe. D—Bottom of Bearing and top of Support machined for accurate alignment. E—Shaft Seal prevents escape of gases from fan.

These Husky Water-Cooled Bearings are Standard on RT Induced Draft Fans

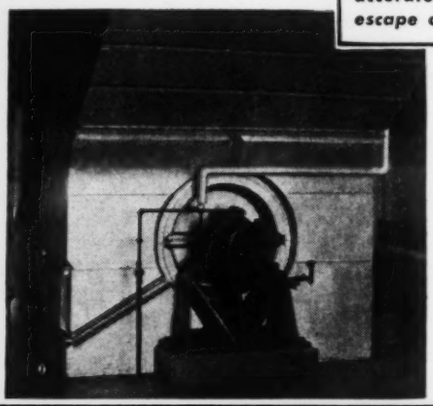
Wheel tip speeds may run as high as 240 miles an hour—temperatures may exceed 700° F.—that's modern induced draft — *toughest of all fan services!*

To help meet such requirements successfully, we equip Clarage Type RT Fans with bearings as shown above. Note liberal size, high grade construction and precision features.

Note, too, that cooling water is circulated through each half of the bearing sleeve independently of the other—no joints or gaskets—no possibility of water leaking into bearing lubrication.

These BETTER bearings are an important factor in assuring each Clarage RT Induced Draft Fan a trouble-free service life far longer than normal expectancy.

And this ability to out-perform and out-last is equally characteristic of other Clarage Fans and Blowers. If you have ANY air handling problem, it will pay you to get in touch with us.



RT Induced Draft Fan installed in central station of large public utility—one of over 2,000 Clarage power plant installations.

Photo illustrates comparative size of fan and bearings—big husky bearings equal to any service condition.

CLARAGE FAN COMPANY—KALAMAZOO, MICH.
SALES ENGINEERING OFFICES IN ALL PRINCIPAL CITIES

COMPLETE AIR CONDITIONING
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COOLING
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FACTORY HEATING
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MECHANICAL DRAFT
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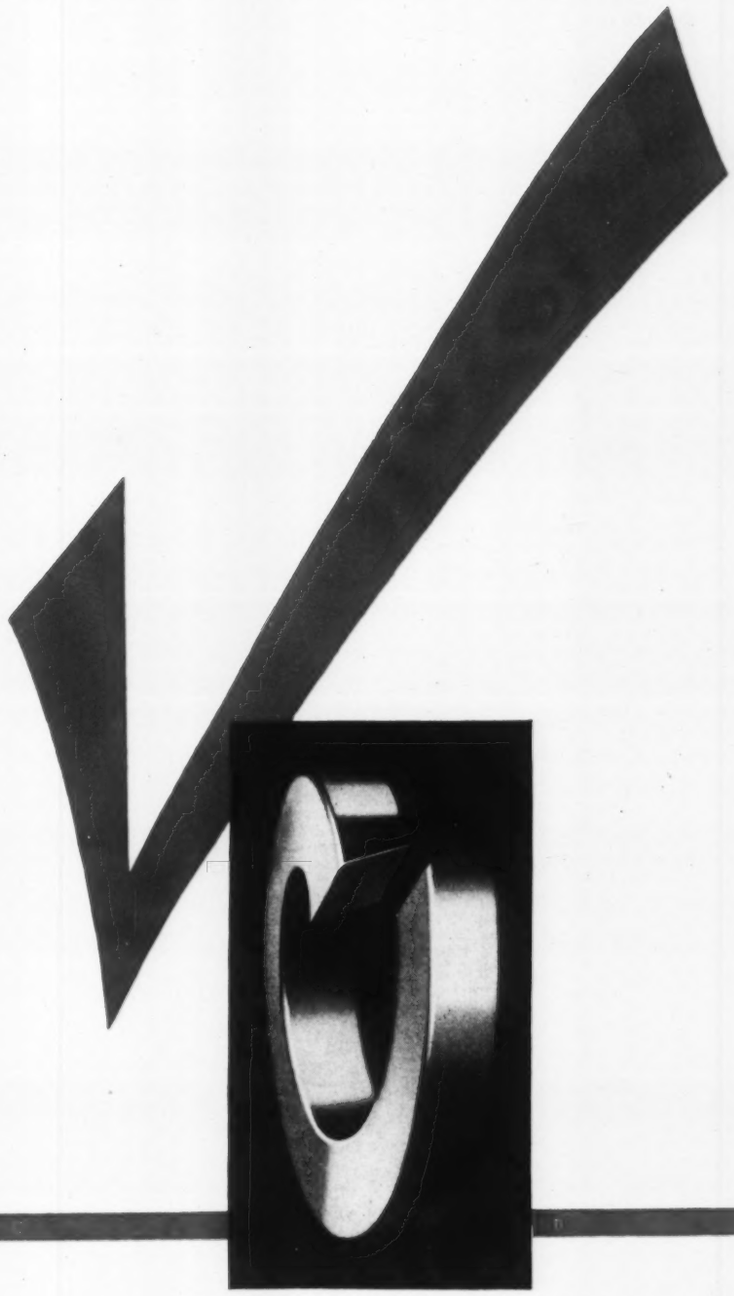
FANS and BLOWERS for INDUSTRIAL NEEDS



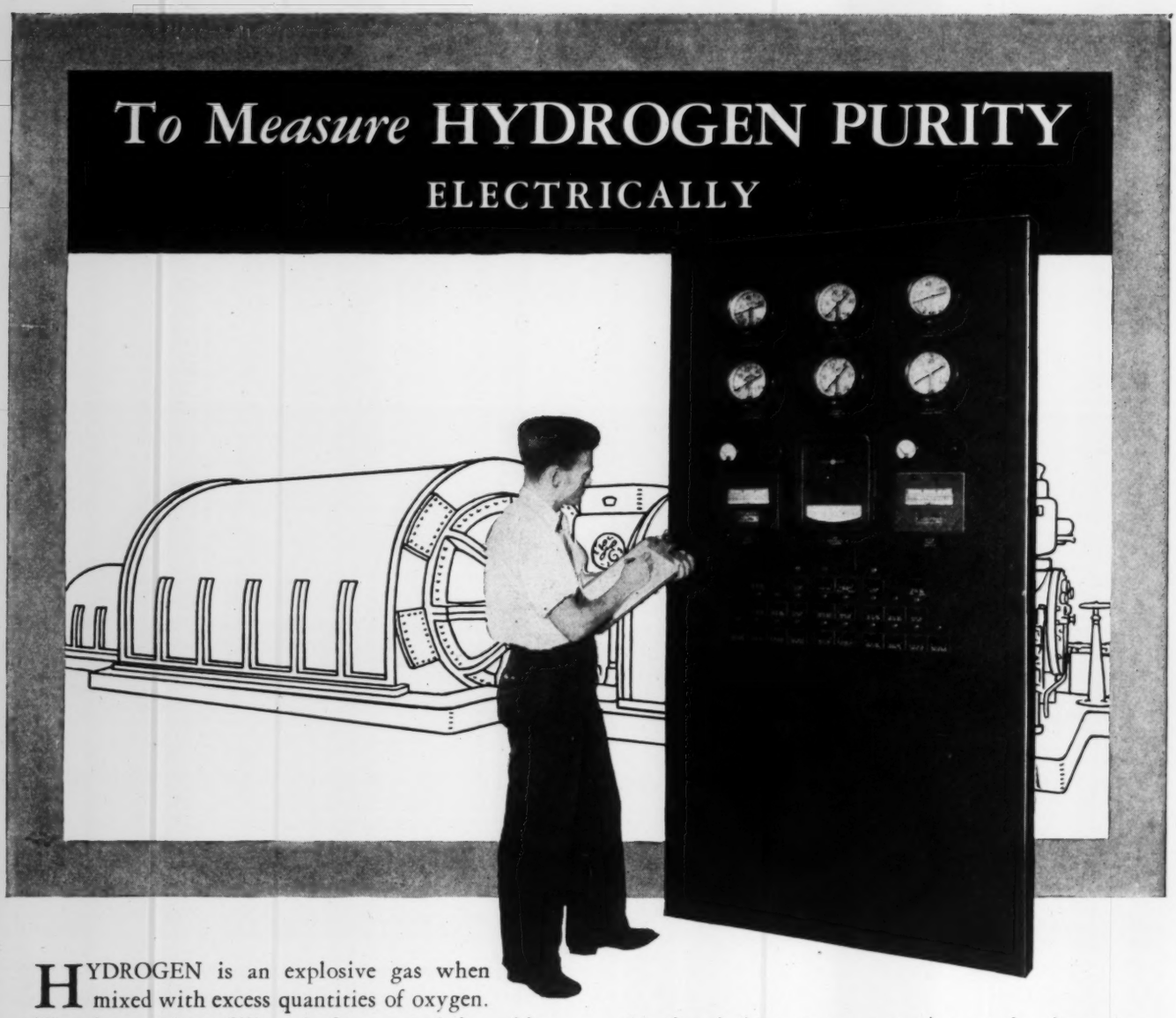
Check the efficiency and cost of KANTLINK Spring Washers against so-called lock washers

No device that exerts *temporary* pressure on the threads over a short range can compensate for the true causes of looseness which are bolt stretch, wear under the nut and bolt head, pulverizing of paint, rust or scale. No so-called locking device has the *long range* of action found in KANTLINK Helical Spring Washers. In addition, spring washers cost less!

KANTLINK HELICAL SPRING WASHERS • WRIGLEY BUILDING • CHICAGO

Specify KANTLINK TRADE MARK Helical Spring Washers

To Measure HYDROGEN PURITY ELECTRICALLY



HYDROGEN is an explosive gas when mixed with excess quantities of oxygen. Therefore, when filling hydrogen-cooled turbine-generators, converters, and condensers, it is necessary to know the hydrogen concentration at all times.

To fill the casing, carbon dioxide is pumped in, and air is let out until the percentage of carbon dioxide in air is about 70 per cent. Hydrogen is then admitted until the percentage of hydrogen in carbon dioxide is about 97 per cent. A somewhat similar reverse procedure is used to empty the casing.

This operation requires a means of measuring the various gas mixtures in order to prevent the formation of an explosive mixture. The changing analysis of the gas must be known throughout the operation, and particularly at the changeover points, so that safety of the procedure is assured. This requires an indicating instrument, for chemical analysis is too slow, as well as too expensive.

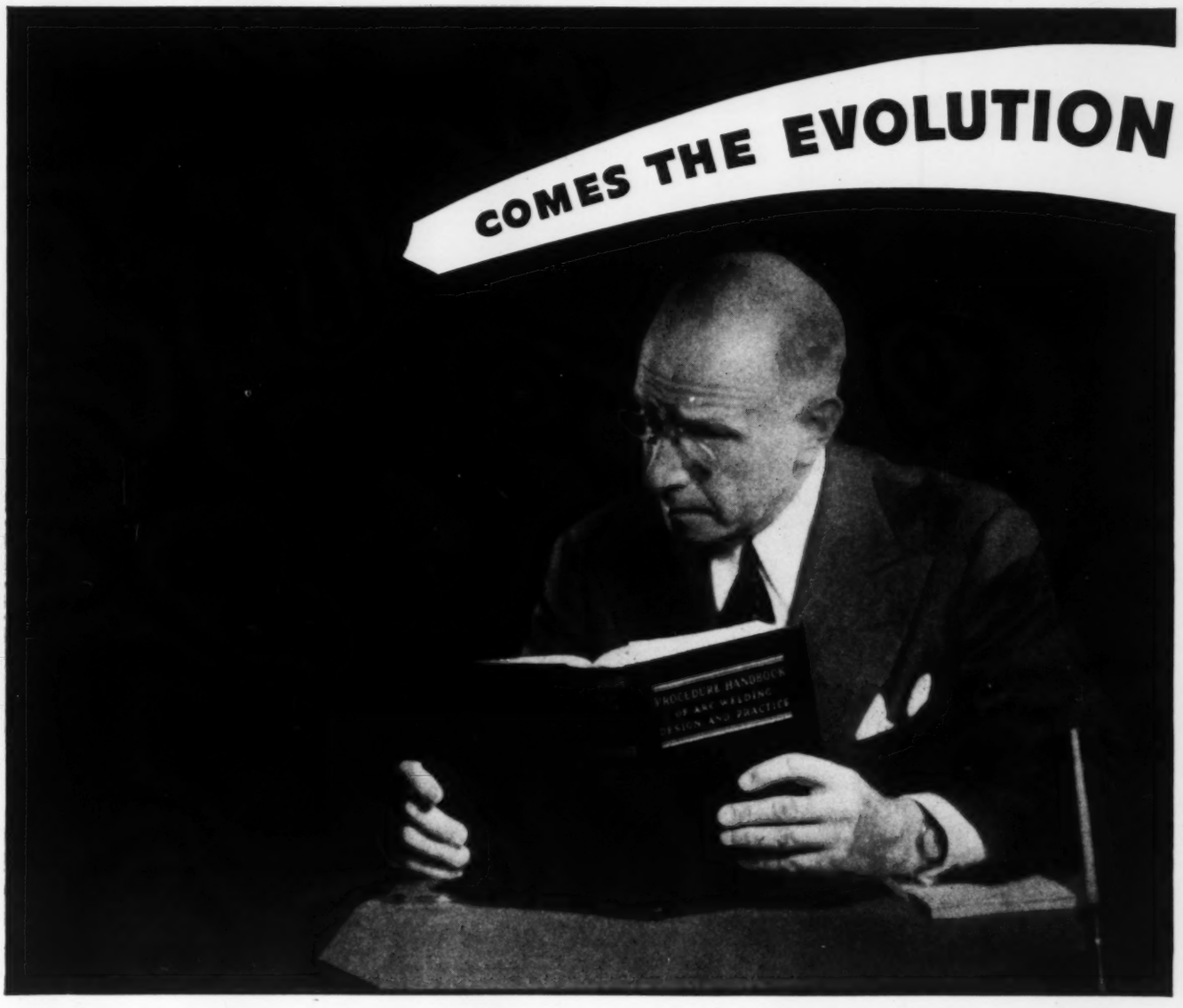
An electric instrument, operating on the thermal-conductivity principle, was developed by G-E engineers for this purpose. In addition to giving a continuous analysis, it indicates the purity of the hydrogen after the casing is filled, and while the machine is in operation. By means of an alarm system, it gives both visible and audible warnings, should the hydrogen mixture drop below a predetermined percentage.

In addition to building instruments for special measurement problems, G.E. offers a complete line of standard instruments for the measurement of any electrical quantity—current, voltage, resistance, watts—in styles and ratings to fill every need. When you have a problem that involves measurement, let us help you solve it. General Electric Company, Schenectady, N. Y.

HEADQUARTERS FOR ELECTRICAL MEASUREMENT

GENERAL ELECTRIC

602 14



ALTER EGO: Literally "one's other self"—the still, small voice that questions, inspires and corrects our conscious action.

ALTER EGO: "Now pity a sorrier fate if you can: A vagabond soul in a stay-at-home man." Remember that poem?

Meaning what?

ALTER EGO: Meaning you're that way about arc welding. You'd like to improve your product and enjoy the saving in cost—BUT you'd rather sit comfy with the old familiar production process.

But we haven't the time *these days to change barrels while going over Niagara Falls.*

ALTER EGO: Then don't change barrels. The most rabid redesign enthusiast will tell you that redesign for arc welding is a matter of evolution, not revolution.

You mean we should do it one step at a time—like learning to walk?

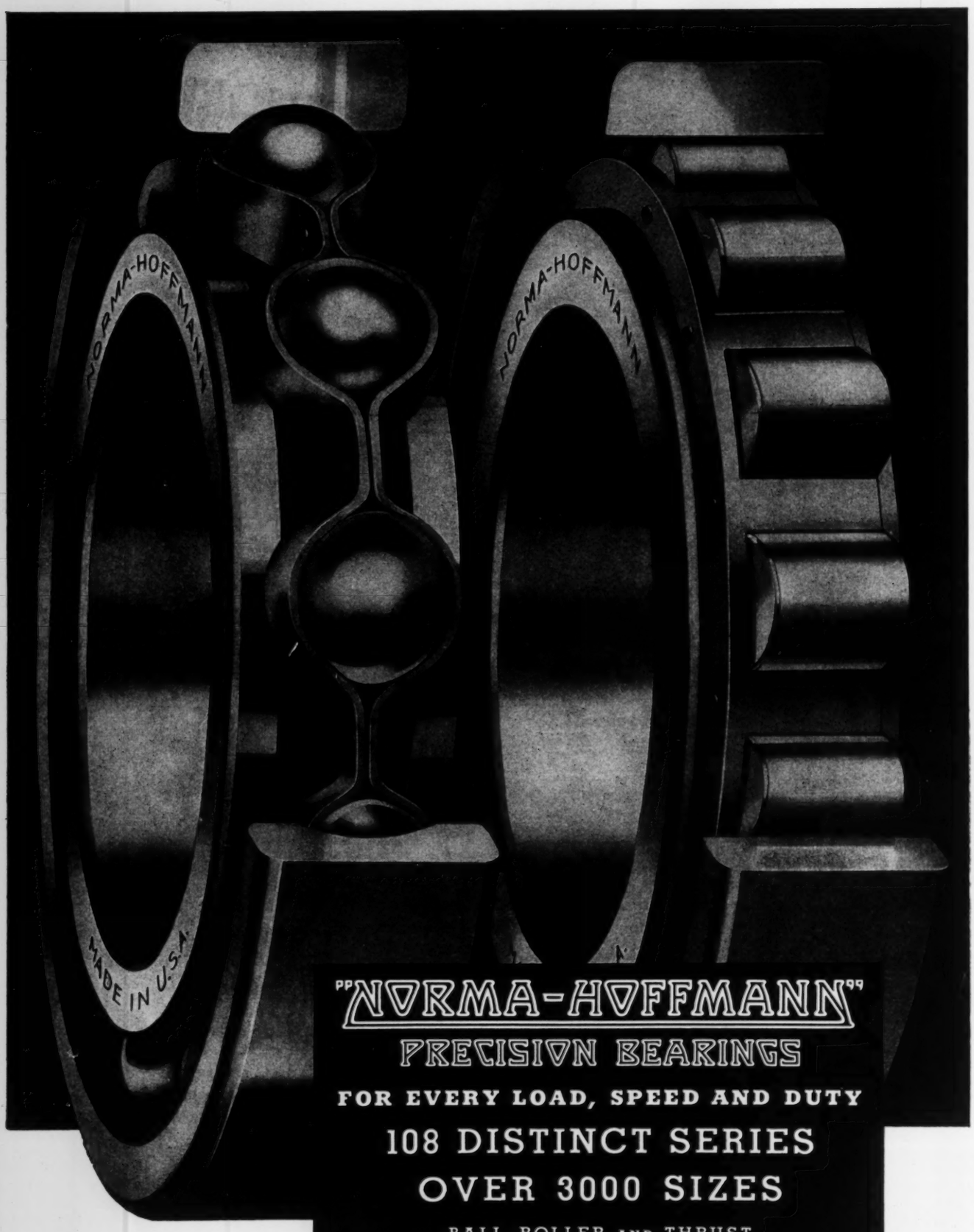
ALTER EGO: Exactly, then when you've perfected the production of one part, take the second step —redesign the next part; and before you know it, you and the product are on the way to town.

• •

LINCOLN SUGGESTS: To the man who thinks he hasn't time or who doesn't know how to change over to welding, we offer this suggestion: See how others, with problems like your own, have started out with welded design. The booklet, "How to Changeover to Welded Design for Profits" (gratis) gives the evidence and a start.

LINCOLN "SHIELD-ARC" WELDING THE LINCOLN ELECTRIC COMPANY Cleveland, Ohio

Authoritative Information on Design • Production • Welding Equipment



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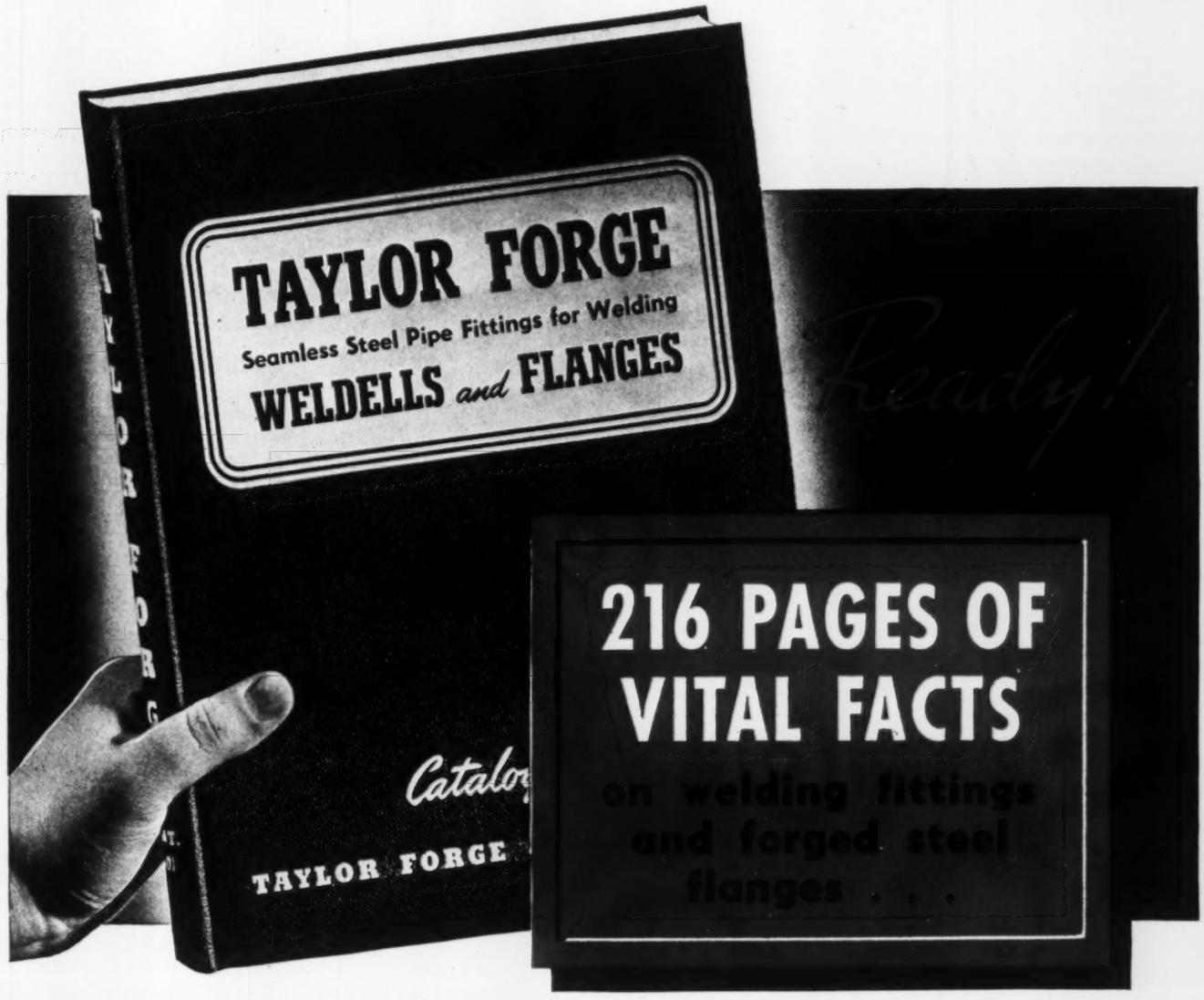

HERE in a permanent, cloth-bound volume you have the most exhaustive and useable treatise ever published on the application of welding fittings and forged steel flanges.

Beyond the particularly complete and clear dimensional and price data covering Taylor Forge WeldELLS and Forged Steel flanges, its 216 pages contain engineering data that will prove invaluable to the man who purchases, designs or specifies piping, fittings and flanges in carbon and alloy steels.

Among the subjects presented are case studies of flexibility in welded piping, comparisons of theoretical with test results, flange bolting data, complete data on standards, pressure and temperature ratings, sub-normal impact testing data—in fact, far more information on welding fitting and flange application than was ever before published in one volume.

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Research Tames

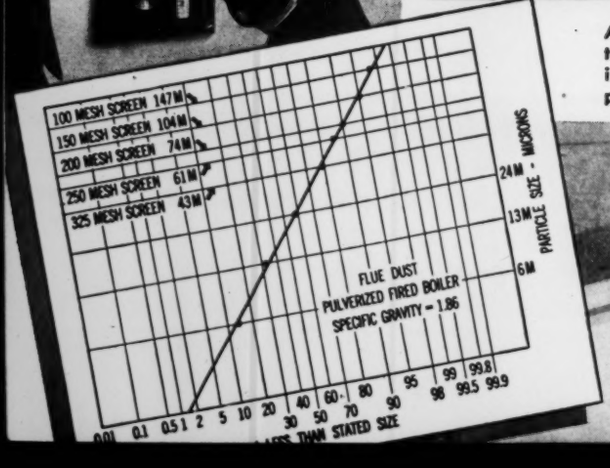
DUST ANALYSIS

Obtaining specimen of dust for analysis and for filing of permanent sample. Photomicrographs are made for visual analysis of size and nature of samples.

Vibrating screens grade dust particles into size groups. Below, unique Air Elutriator then separates dust, too fine for sieve grading, into 4 fractional sizes.

EQUIPMENT DESIGN

The Detriscope, shown below, gives an actual picture of the passage and distribution of dust through a cyclone—and thus permits more efficient design.


100 MESH SCREEN 147M
150 MESH SCREEN 104M
200 MESH SCREEN 74M
250 MESH SCREEN 61M
325 MESH SCREEN 43M
FLUE DUST
PULVERIZED FIRED BOILER
SPECIFIC GRAVITY = 1.86
PARTICLE SIZE - MICRONS
24M
13M
6M
0.01 0.1 0.5 1 2 5 10 20 30 40 50 60 70 80 90 95 98 99 99.5 99.8 99.9
LESS THAN STATED SIZE

All dust fractions are carefully weighed to determine the percentage of each size in the sample. These percentages are plotted as shown in the graph, left.

Determining specific gravity of the dust. From the complete analysis, the performance of this dust in a cyclone can be accurately determined.

FLUE DUST

Special Sturtevant Laboratory concentrates on dust problems

The abrasive action of flue dust on induced draft fans, and the nuisance of fly ash, have long been problems of power plant engineers. Today, because of the increased use of pulverized fuel and greater boiler loads, these problems are even more acute.

While much progress in flue dust control has been made by Sturtevant since the development of the first Sturtevant fans over 80 years ago, today's increasingly serious flue dust problems demand special attention. To meet this need, the new, scientifically equipped Sturtevant Dust Laboratory, shown, has been established. It is concentrating a major part of its efforts on the flue dust problems of central stations and industrial plants.

Here, flue dust particles so small that they are invisible to the naked eye are considered of importance. They are painstakingly measured, graded, weighed, analyzed — because all this must be done before *adequate* collecting equipment can be designed.

Special equipment is utilized to classify the flue dust into even the finest micron sizes. New testing equipment was developed to determine the relative efficiency of separators. And finally, to insure installation performance in line with laboratory results, even new field testing equipment was developed.

The Sturtevant Dust Laboratory has enlarged the field of knowledge regarding flue dust control; improvements in collecting equipment have been achieved; and installations incorporating these improvements are already in successful operation.

B. F. STURTEVANT COMPANY, HYDE PARK, BOSTON, MASS.

Branch Offices in 40 Other Cities B. F. Sturtevant Co. of Canada, Limited — Galt, Toronto, Montreal

Sturtevant

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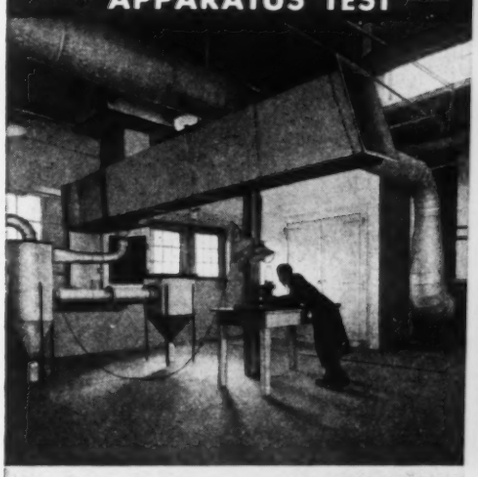
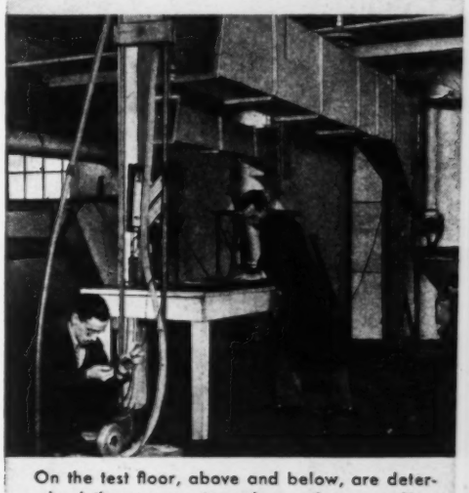
Puts Air to Work

APPARATUS TEST

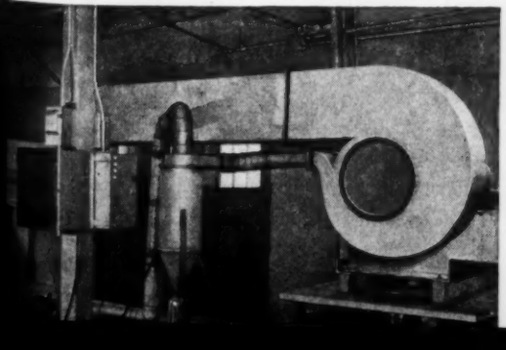


Because the performance of dust collectors is directly affected by the size and nature of dust particles, efficiency tests with various types of flue dust are made on all new cyclone designs.

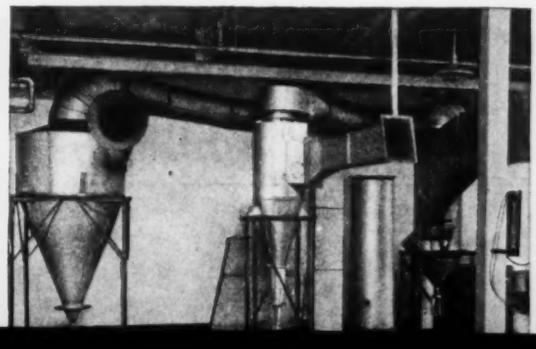


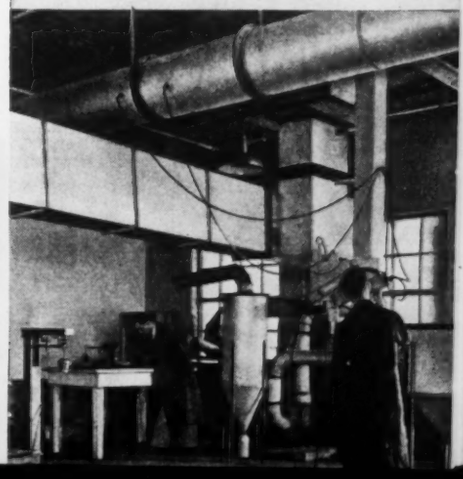
On the test floor, above and below, are determined the answers to such questions as:—How does size of dust and size of collector affect efficiency? How does air velocity affect resistance and efficiency?

S-A Dust Collection Fan shown on a controlled test run. Fan at right separates and passes all the dust and approximately 10% of the air to the cyclone, which then completes the separation.



Tests on the Buell-VanTongeren Cyclone, center, and Sturtevant Cyclones, left and right, are used in combination with dust analysis in the solution of specific dust problems.





MORE STRENGTH TO MEET STRESS...

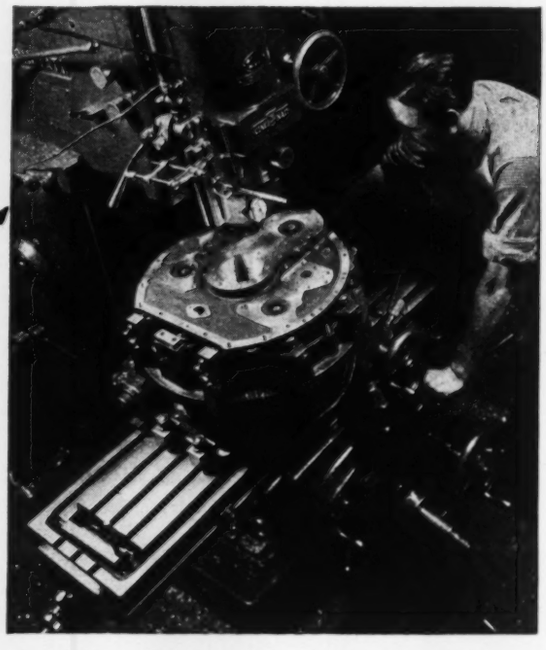
50 *places in a power shovel...*

85 *places in a rock drill...*

275 *places in a milling machine*

NICKEL ALLOY STEELS

Measured by weight, nearly ⅓ of this Bay City power shovel is fabricated from long-wearing Nickel alloy steels. 50 vital parts which must withstand fatigue strains, shock stress and overloads are made of SAE 3135 oil quenched Nickel-chromium steel and other Nickel alloy steels. Frames and bases are Nickel cast steel. "Chabelco" crawler drive chains, Diamond crowd chain, Hercules gasoline and Caterpillar Diesel engines on Bay City shovels also employ high strength Nickel alloy steels for important stressed components.



More than 275 stressed parts in this dial type Cincinnati milling machine are Nickel alloy steels. Nearly 200 of these parts are made of a Nickel-chromium steel, heat treated to high strength yet readily machinable. Parts subject to wear are case-hardened.

Here are five Gardner-Denver rock drills mounted for tunnel driving. In each drill, 85 stressed parts are produced from Nickel alloy steels. The Gardner-Denver Co. writes, "Through increased use of Nickel alloy steels, remarkable improvements in performance and reduction in maintenance costs have been accomplished—without comparable increase in weight or bulk."

• • •

➡ Purchasing and production are often simplified because the versatility of Nickel steels usually permits one Nickel steel to efficiently serve many purposes. Practical answers to your inquiries will be given promptly, based upon our broad experience with many industries. Please address:

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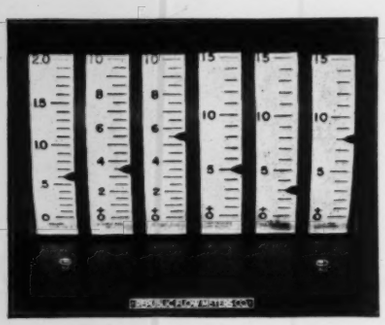
• NEW EQUIPMENT

New Multi-Point Indicator

For indicating drafts, pressures, differentials, and other factors in boiler and industrial furnace operation, a new Republic multi-point indicator has just been placed on the market. Zero adjustments and all piping connections for each gage unit are accessible from the front of the panel and



each unit is designed to be withdrawn, like a book from a shelf, without disturbing other units. Each gage is actuated by a very sensitive dry-bellows type of diaphragm for ranges from 0 to 50 inches of water or by a helical element for pressures above 50 inches of water. The gages have 12-inch vertical, translucent, rear-illuminated scales. The new indicator is supplied with from 2 to 16 of these compact, interchangeable gage units, and is built for either flush or projected mounting. It is described in detail in Bulletin No. 801, just issued by Republic Flow Meters Co., 2232 Diversey Parkway, Chicago, Ill.

New Fast-Printing Whiteprint Machine

A new medium priced Model "F" Whiteprint machine has just been announced by Ozalid Products Division, General Aniline & Film Corporation, Johnson City, N. Y.

This equipment constitutes a printer and dry-developing unit built into a single, compact machine in which are incorporated all the facilities necessary to turn out finished dry-developed Ozalid Whiteprints.

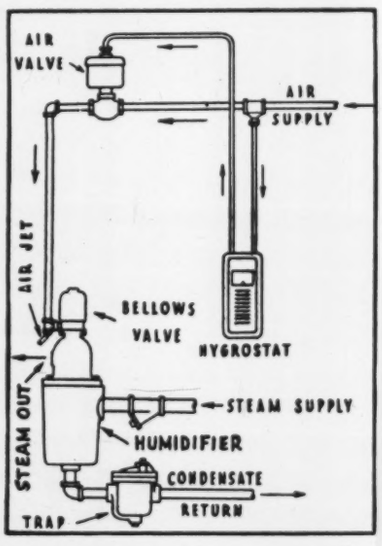
Equipped with a new type high pressure mercury vapor lamp, which uses 40 watts per inch and has an active length of 46", the Model "F" will print Ozalid sensitized materials at speeds up to 56" per minute. The lamp gives uniform light distribution over the entire printing surface. It is guaranteed for 1,000 hours but tests indicate a life of from 1500 to 2500 hours. Lamps which burn out can be reworked for considerably less than the purchase price of a new lamp. The efficiency of the new Model "F" light source cuts electrical consumption more than 50% of that required by other machines of similar capacity.

An adjustable light shade allows the operators to vary exposure without changing the printing speed. As a result, prints can be handled efficiently and a smooth flow of work maintained despite the variations in the transparency of tracings.

Even cooling of the lamp, which is so necessary for uniform light distribution is provided by a two-stage blower and a specially designed air duct. This cooling system effectively prevents high temperature differentials between the right and left sides and insures long life of the lamp. Maximum lamp efficiency is assured by a reactive type transformer equipped with condensers providing power factor correction to 87.5%. The terminal board on the transformer permits adjustments to correspond with actual line voltage variations from 200 to 240 volts.

A Veeder-Root Counter automatically registers the number of hours this machine operates. This enables the operator to determine at a glance exactly how long the machine has been in operation.

New Air Operated Humidifier



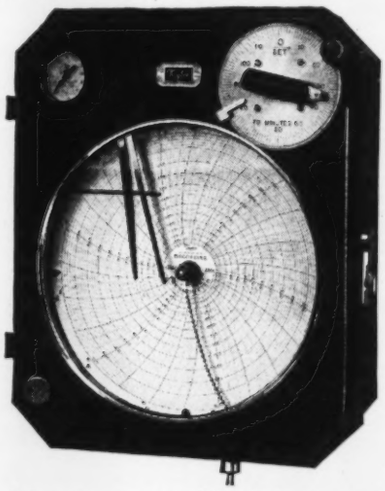
Development of an air operated steam type humidifier for installation in locations where electric circuits would be undesirable is announced by Armstrong Machine Works, 894 Maple St., Three Rivers, Mich. It is believed that the unit will have a considerable field of use in chemical or processing plants using inflammable solvents, in munition plants handling gun powder, in milling plants having dust explosion hazards, and in hospitals using explosive anesthetics.

As shown by the accompanying diagram, the assembly includes a pneumatic hygrostat which acts as a pilot valve to admit pressure to the diaphragm chamber of the main valve where the relative humidity drops below the desired percentage. Opening of the main air valve allows compressed air to flow to the humidifier when the pressure builds up and opens a steam valve in the top of the humidifier. The steam valve admits steam to a special silencing chamber in the humidifier from whence it escapes directly to the atmosphere to add humidity to the room. Circulation and distribution of the steam is facilitated by allowing a small amount of compressed air to blow through a nozzle directly above the steam outlet.

To insure dryness of the steam released by the humidifier, the entire silencing chamber is jacketed with steam at a pressure several pounds above atmosphere. Use of a steam trap prevents accumulation of condensate in the steam jacket. Compressed air for the humidifier may be at any pressure from 20 to 100 lbs. or less. The unit has a maximum capacity for adding moisture to air at the rate of 44 lbs. per hour. Under average conditions this is sufficient for 40,000 cu. ft. of space.

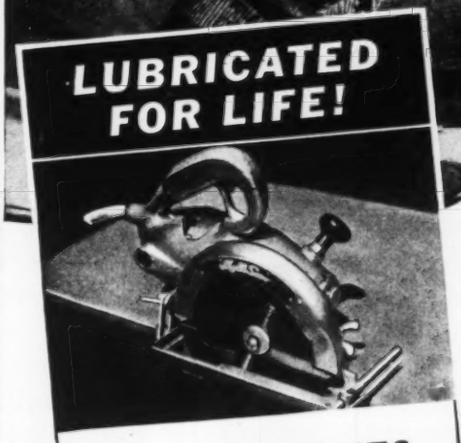
Process Timing Mechanism for Taylor Fulscope Recording Controllers

Exact duration of batch processing, as well as precise temperature or pressure control on applications such as hosiery dye machines, canners' retorts, vulcanizers, etc., can now be assured with the new Process Timing Mechanism for Taylor Fulscope Recording Controllers. Introduced by the Taylor Instrument Companies, of Rochester, New York, this modern, all electric timing mechanism is as positive as your electrical current.



It's easy to operate. The timing process is manually started by adjusting the instrument for the desired time period. With this new Taylor feature, the timing automatically starts, not immediately, but when the apparatus reaches the set point of the controller. The length of time required for this set point to be reached makes no difference in the operation of the new Taylor Timing Mechanism.

Continued on Page 20



7 QUICK FACTS:

1. Produces a wear resistant film on working surfaces.
2. Resists rust, corrosion and pitting.
3. Lowers maintenance and power costs.
4. Lubriplate is white and clean.
5. Outlasts ordinary lubricants many times.
6. Cheapest in the long run. A little goes a long ways.
7. Available in fluid and grease types for your every need.

"Here's Why LUBRIPLATE LUBRICANTS Got the Job!"

writes the Power Tool Designer, Mall Tool Company, Chicago, Ill.

"THIS SAW was designed for the toughest sort of use and abuse . . . to stand up through all kinds of weather —rain, snow, sleet. Naturally, we needed as nearly perfect a lubricant as it was possible to obtain, especially since the housing is completely sealed in.

"After thorough tests, we selected Lubriplate Lubricants for the job . . . and are glad to state that Lubriplate has proved 100% satisfactory. Lubriplate shows an amazing resistance both to wear and to moisture . . . and its use insures quiet, efficient operation."

Literally hundreds of other leading manufacturers of every kind and description who have selected Lubriplate above all others say the same thing: "Lubriplate is the *modern* lubricant, created to meet *today's* high speeds; *today's* increasingly heavy loads."

Why not prove to yourself that Lubriplate is the one lubricant that will cut your lubricant, labor and replacement costs? Simply pick out the toughest lubricating job in your entire plant and give this modern lubricant a trial. You'll notice the difference immediately!

FISKE BROTHERS REFINING CO. NEWARK, N. J. • TOLEDO, O.

Dealers from Coast to Coast

LUBRIPLATE LUBRICANTS

TRANSMISSION OF POWER WITH LESS LOSS—LESS WEAR—LESS COST

Continued from page 18

Timing begins only when the set point has been reached. At the end of the desired period, Taylor Timing Mechanism automatically terminates the process.

To facilitate the timing of successive batches of the same duration, a "stop" is furnished on the Timing Mechanism dial. With this "stop" set at the desired timing period, the pointer can be quickly spun to the "stop" and the starting operation speeded up.

New Aircraft Welding Applications Made Available by New Electrode

Two important new applications of the electric arc in aircraft structural welding have been prompted by the urgent necessity for fast production in National Defense.

These new uses for arc welding include fabrication of engine mounts and landing gear forks and other applications.

Both have been made possible by development of a new electrode designed and manufactured by The Lincoln Electric Company, Coit Road & Kirby Ave., Cleveland, Ohio, expressly for plane welding. Known as "Planeweld," the electrode is of shielded arc type for welding SAE-4130 and X-4130 chrome molybdenum steels, which are widely used in airplane construction. "Planeweld" is suitable for welding in all positions and when used on steels of the types mentioned provides weld metal with physical properties similar to the metal welded. Its welds are smooth without undercutting. There is minimum spatter and good crater conditions and welds made by the electrode on such steels respond to heat treatment quite similar to the parent metal. Planeweld comes in two types—Planeweld No. 1 for material .120" and heavier, and Planeweld No. 2 for light gauge airplane parts (up to approximately $^{7}/_{64}$") and airplane tubing.

The new electrode which was developed to overcome difficulties formerly encountered in airplane welding is available in four sizes: Planeweld No. 1 in $^{1}/_{8}$", $^{5}/_{32}$" and Planeweld No. 2 in $^{1}/_{16}$" and $^{3}/_{32}$". It is suitable for welding airplane fuselages, tail supports, torque tubes, bomb mountings, alloy chain links, antenna mounts, chairs, as well as engine mounts and landing gear forks, or any other airplane part constructed of the steels mentioned.

Improved Asphalt Tile Announced by the Philip Carey Co.

The research laboratories of The Philip Carey Mfg. Co., Lockland, Cincinnati, Ohio, has developed an improved asphalt tile which is said to have a smoother and more attractive surface and to possess specific advantages for use both as an industrial flooring and for protection of roof areas which are used for recreational or other purposes.

This new product, which is marketed under the trade name of Elastite Asphalt Tile, is a compound of asphalt and mineral filler, reinforced with asbestos fibres, densely compressed and die cut to size, and is now approved by the Underwriters' Laboratories for "Class A" built-up roofing, when applied in accordance with their instructions, on slopes up to and including 1" to the horizontal foot. It should not be confused with asphalt paving blocks or asphalt floor mastics.

Carey Elastite Asphalt Tile is manufactured in standard black and standard red, in $^{1}/_{4}$" thickness, and in sizes 12" x 12" and 12" x 24". This product is said to be extremely dense, tough, highly resistant to compressive loads, dustless and quiet under wheel traffic. While relatively hard, it is not rigid or unyielding, thereby contributing to workers' efficiency. It may be applied to any properly prepared sub-base and is ready for use as soon as laid.

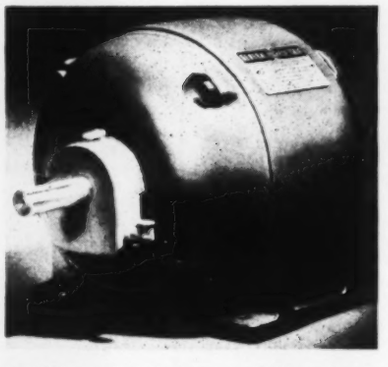
Other advantages claimed for it are: 1—High resistance to fire. Having a flash point of approximately 700°F., it will not create a fire hazard. 2—Dielectric Strength. Its breakdown voltage of over 30,000 volts indicates an electrical insulating value approximately equal to that of marble and much greater than that of slate. 3—It is vermin and rot-proof. 4—Practically non absorbent in the presence of water, thus providing protection against dampness which may exist under the sub-base.

Elastite Asphalt Tile is recommended by the manufacturer for general use as flooring for factories, warehouses, loading platforms, schools, stores, restaurants, offices, etc., where suitable sub-base exists and where loading, temperature and chemical conditions fall within proper limits. It also has wide application for surfacing roof areas for outdoor terraces, sun decks, or recreational purposes.

This latest development in asphalt tile, with its more pleasing appearance, is reported by The Philip Carey Co. to be meeting with most favorable acceptance by architects and the building industry.

The New G-E Polyphase Motor

As a result of a broad survey of the changing requirements of its industrial customers, General Electric announces an entire line of completely new polyphase induction motors, in integral horsepower sizes, to conform with new industrial trends, processes, and practices. Known as the Tri-Clad motor and representing one of the most extensive product changes in the history of the company, it has called for many new methods in G-E motor manufacturing.



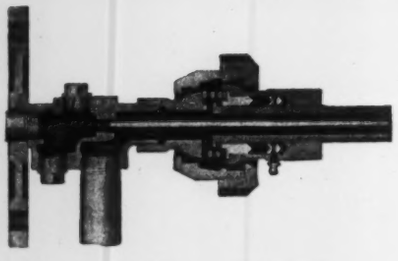
In all its ratings it features modern streamlined appearance; more complete protection—through the use of a cast-iron frame—than heretofore available except in especially enclosed machines; major advances in the insulation of current-carrying parts; and improved bearing design and lubricating arrangements. At the same time, it incorporates the cast-aluminum rotor, pressure-relief system of greasing for ball-bearing motors, and other proven features. In addition, however, it offers many new convenience features.

In recent years there has been an increasing and widespread demand for more protective features in open, general-purpose motors. Thus, despite its striking modern appearance, major industrial interest in the new G-E

Continued on Page 22

BARCO REVOLVING JOINTS

Prove Their Efficiency
Through Lower Power Costs



Type 7R-8CR
with
Adapter 18R

Two Ball Seats *provide* Flexibility,
Eliminating Strain on the Revolving Sleeve

Heat or Cool Rotating Rolls
at Lowest Maintenance Costs

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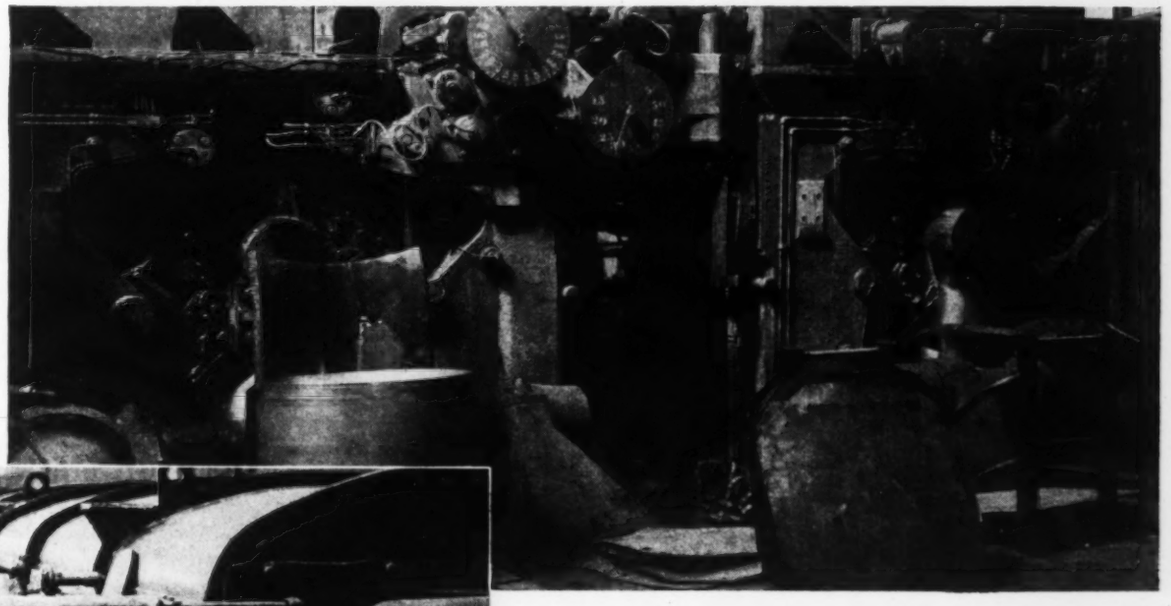
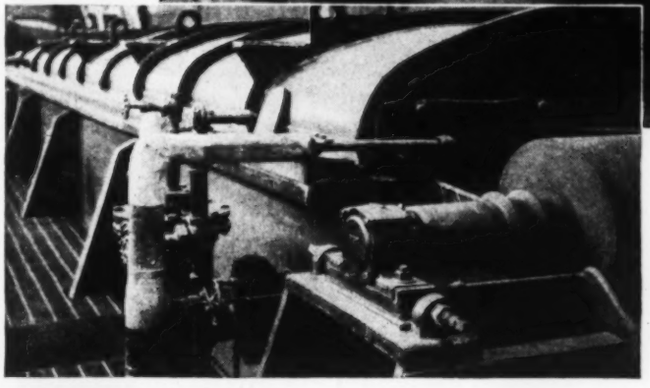
SKF's are working

AT THE INDIANA HARBOR WORKS

of Youngstown Sheet & Tube Co.





In the Indiana Harbor Works, you will find SKF Spherical Roller Bearings doing a variety of jobs from end to end of the mill and from top to bottom . . . from Roll Grinders to Hot Strip Coilers built by Mesta Machine Company . . . Strip Scrubber Line built by Youngstown Foundry & Machine Company . . .Cranes built by Morgan Engineering Company . . . Motors built by Westinghouse Electric & Manufacturing Company.

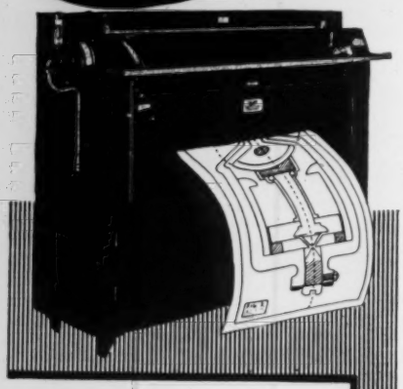
You will find SKF Bearings on *modern* steel mill equipment WHEREVER YOU GO because their quality and practical design enable them to do the job *right.* They are self-contained, and their rolling alignment compensates for warpage, deflection and misalignment. Their high capacity is always 100% available. They need no adjustments, either in assembly or for wear. By using SKF Bearings, you, too, can put the *right* bearings in the *right* places.

4646

SKF INDUSTRIES, INC., PHILADELPHIA, PA.

SKF Bearings

PRINTS
ON THE SPOT
IN A HURRY
WHEN YOU WANT
THEM



Present day production demands split-second timing. Waiting for prints cannot be tolerated.

The new fast-printing Model "F" Whiteprint Machine delivers a finished dry developed Ozalid whiteprint made from an average pencil tracing in less than 2 minutes.

It makes prints right on the job . . . quickly . . . without washing, fixing, drying or trimming. You get prints when you want them . . . when you need them.

Send for Model "F" circular and free booklet of dry developed Ozalid prints.

ONLY OZALID HAS DRY DEVELOPMENT

OZALID PRODUCTS DIVISION
GENERAL ANILINE & FILM CORPORATION
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• Keep Informed . . .

Continued from page 20

motor will undoubtedly center around its outstanding mechanical and electrical protective features. In place of the conventional open frame, it makes use of a cast-iron frame of the box type. The end shields are designed to match the frame and are enclosed above the centerline. This combination of frame and end shields minimizes contact of vital motor parts with foreign material such as lubricants, coolants, and other liquids, as well as chips, tacks, etc., while also protecting it against accidental blows in handling or similar rough usage. The new-type insulation, dust-tight bearings, and the use of Glyptal in the priming and finishing paints armor it against the attack of harmful agents.

Convenience Features

A new and wider conduit box, with unusually large working space, simplifies installation in close quarters. The box, whether the pressed-steel or watertight type, may be mounted in any one of four positions.

Clearly marked terminals permanently identify the leads.

The stator is reversible and allows the conduit box to be located on either side and up or down on side-wall mounting.

Ball-bearing motors can be operated vertically or mounted on a side wall.

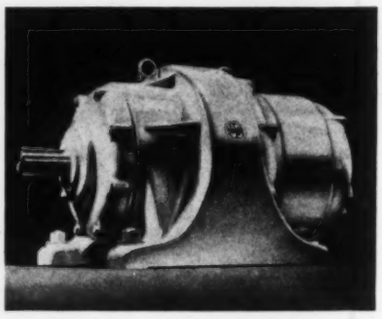
The end shields can be easily changed to any one of four positions on the job.

The oil-filler gage can be located on either side. In all frames larger than Frame 254, a drain plug, located at the lowest point of the oil reservoir, permits complete draining of the bearing housing without tilting the motor.

The same assembly of shaft and rotor is used on many popular sizes of both sleeve- and ball-bearing motors. Thus, many sleeve-bearing motors may be converted to ball-bearing by changing only the end shields, bearings, and caps. Likewise, ball bearing motors can be converted to sleeve bearings, if precautions are taken to prevent damaging the journals when removing ball bearings.

The complete sleeve bearing utilizes hard-tin babbitt centrifugally cast into a steel shell. The bearing is rigidly supported through 360 degrees and is locked in a dust-tight, oil-tight enclosure by a removable pin.

Large Horsepower Gear Motors



New double and triple reduction geared motors up to 30 horsepower at 91 RPM have been added to the U. S. Syncrogear line. The larger unit incorporates the pyramidal gear pedestal design which provides ample support to withstand the extra torsional strains and load shocks of geared power.

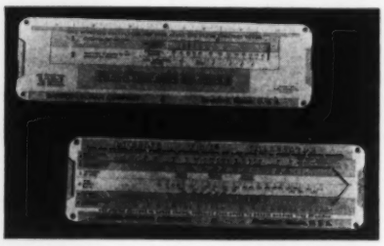
All castings used in this new line of large Synchrogear Motors are normalized, and permanent alignment of bearings and gears is thereby assured. The removal of all internal stress in the castings by normalizing, prevents warping with age and adds years of trouble-free service.

Both primary and secondary gears dip in a large oil reservoir in the Pyramidal base of the Syncrogear Motor. This design provides an ample oil supply to all bearings and gears without submerging any rotating parts.

Write for Syncrogear Bulletin: U. S. Electrical Motors, Inc., Dept. 76, 80—34th Street, Brooklyn, New York.

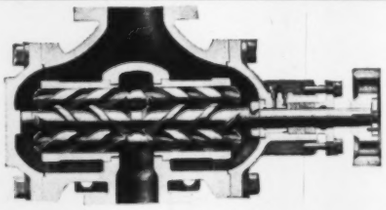
Hobbing Time Calculator

A slide rule, designed to simplify the calculation of hobbing time, has been developed by the Barber-Colman Co., Rockford, Illinois, manufacturers of an extensive line of hobbing machines, hobs, milling cutters, reamers, bench centers, and sharpening machines for hobs, cutters, and reamers.



This new time calculator is a great improvement over the former calculator. One side permits the calculation of the "hob approach" for spur gears, spline shafts, and other straight forms. To get this dimension it is necessary only to set the diametral pitch under the arrow and read the hob approach in inches directly above the diameter of the

Continued on Page 24



Gambling may be fun

BUT- should your turbine, engine or oil burner fail through failure of the oil pump, the cost of that failure might be many times the cost of the oil pump; so why gamble on the oil pump?

The DE LAVAL-IMO OIL PUMP is a guarantee against oil handling troubles.

It has no valves, no gears and only one stuffing box and does not depend upon close clearances.

It pumps all grades of oil, including light Diesel oil, lubricating oil and heavy Bunker C, against all pressures.

Ask for Catalog 1-63.

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Plotting
TO INCREASE YOUR PRODUCTION COSTS?

IS THERE plotting between your pumps and the power meter—plotting to increase your production costs right at a time when such increases would be disastrous?

There IS if your pumps are as much as ten years old. Yes—even if those old pumps could function as efficiently as when they were brand new (which is impossible)—they are costing you at least 10% more to operate than pumps should.

Today's Fairbanks-Morse Pumps are at least 10% more efficient than the same type pumps of ten years ago. They pump greater volume—for less money.

To pay 10% more than you need to pay for ANY operation is too much. You *may* be paying *even more than that!* Why not find out definitely? Write Fairbanks, Morse & Co., Dept. 59, 600 South Michigan Avenue, Chicago, Illinois. Branches and service stations throughout the United States and Canada.

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FAIRBANKS-MORSE CENTRIFUGAL PUMPS—a complete "family" of single-stage, split-case pumps for low, moderate, medium, and high heads with capacities up to approximately 6000 g.p.m. for heads up to 280 feet. Write for Bulletin 5810D.

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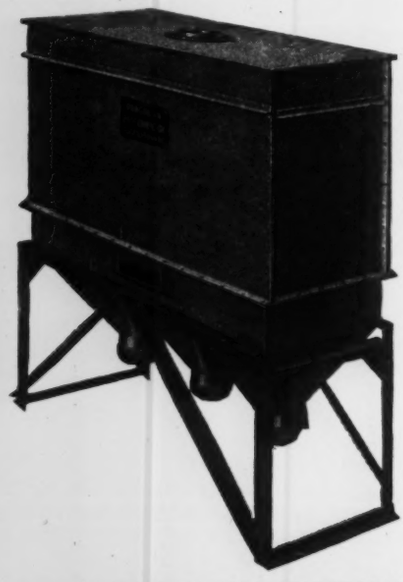
THE DUST HOG--
TURN HIM INTO PROFIT

HOW? With a Pangborn Cloth Screen Dust Collector. For more than 25 years this method has been successfully used by industry in all parts of the world — for all types of dusts.

The small Dust Collector illustrated below is shipped fully assembled, ready for immediate use. Its cost is easily within reach, even of the smallest plant. Write for information on Type "CD" Dust Collectors.



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THE WORLD'S LARGEST MANUFACTURER OF DUST CONTROL AND BLAST CLEANING EQUIPMENT
PANGBORN CORPORATION · HAGERSTOWN, MD.

• Keep Informed . . .

Continued from page 22

hob used. This amount, when added to the length of the spline, or width of the gear face, gives the total length of hob travel which is used in calculating the hobbing time.

The hobbing time is very easily calculated by means of setting the two slides on the reverse side in the order indicated on the rule. The procedure is as follows:

1. Set the Feed per Revolution of work below the total hob travel on the first slide.
2. Then set the Hob Speed R.P.M. below the particular thread hob used (whether single, double, or triple thread) on the second slide.
3. Then read the time required in minutes below the number of teeth being cut.

The rule contains all of the standard hob speeds that are found on Barber-Colman hobbing machines. In addition an 8 inch scale is incorporated on one edge. By a slight amount of interpolation on the hob speeds, this Hobbing Time Calculator can be of equal value for determining hobbing times on other makes of hobbing machines.

Hobbing Time Calculator is available, free of charge, to all time estimators, production managers, superintendents, foremen, etc., who have to do with hobbing problems. Ask your Barber-Colman representative for one, or write direct to the Barber-Colman Co., Rockford, Illinois, stating your company's name and your title.

• BUSINESS CHANGES

Johns-Manville Expansion Program

A $625,000 expansion program by Johns-Manville has been approved by the directors, according to President Lewis H. Brown. The program will include the installation of manufacturing equipment in the recently acquired plant at Zelienople, Penna., where insulating brick will be manufactured, and the building of new warehouses at the company's plants at Nashua, N. H., and Richmond, Ind., the announcement said.

Instead of meeting in the board room in New York, the directors went to the company's Manville, N. J. plant, 35 miles away, and spent the entire day in the various plant departments studying production and research activities. After the all-day inspection tour, they held their regular monthly meeting in the plant cafeteria.

Robins Conveying Belt Advertising Department Reorganized

The Robins Conveying Belt Co., Passaic, N. J., makers of material handling equipment, have completed the reorganization of their Advertising Department. H. Von Thaden, Vice-President and Sales Manager of the company, has announced the appointment of Alfred S. Otton as Advertising Manager. Mr. Otton will be assisted in his new duties by E. E. Riches and John M. Lupton.

The new Advertising Manager, Mr. Otton, has been associated with the Robins Company since 1937, having recently been in charge of all screen cloth sales. He was formerly associated with the late William L. Fewsmith who for many years was the Company's Director of Advertising and Publicity. Mr. Riches has been connected with both the Engineering and Preliminary Design Departments of this company for many years. Mr. Lupton comes to the company with a wide background of experience in advertising and printing.

Last May, the Robins Conveying Belt Co. moved its general offices from 15 Park Row, New York, N. Y., to a new administration building at Passaic, N. J., where for many years its factories have been located. The company manufactures a complete line of Belt Conveyors, Idlers, Vibrating Screens, Feeders, Grab Buckets and other Material Handling Equipment.

$11,500,000 Expansion by G-E Turbine Dept.

General Electric is spending $11,500,000 in expanding present facilities for manufacturing propulsion equipments for the U. S. Navy, it was announced here today by Charles E. Wilson, president of the company. This is in line with the company's policy of anticipating, insofar as is possible; the requirements of the defense program for regular lines of G-E equipment.

The expansion program involves equipping an existing building at the Company's Erie (Pa.) Works with heavy machinery for the manufacture of large steam turbines required by destroyers and light cruisers, and enlarging two of its Lynn (Mass.) shops where reduction gears for the propulsion equipments are made.

"The additional facilities obtained by this expenditure will release available capacity at Schenectady for the manufacture of the large turbines for battleships, as well as those regularly manufactured for our utility customers," Mr. Wilson said. "At the present time, General Electric has on order or is building land and marine turbines totalling 6,000,000 horsepower, 3,000,000 horsepower of which is for U. S. Navy ships."

Mr. Wilson said that the Navy Department had expressed its appreciation of General Electric's willingness to carry out the expansion program, and has indicated that the co-operation will expedite materially the government's program of national defense.

Equipping the existing shop at Erie for manufacture of turbines will cost $8,500,000. Delivery of the first units from that point will be made toward the end of 1941.

"Fortunately, the shop at Erie is immediately available and is ideally suited for heavy manufacture," Mr. Wilson explained. "Crane facilities are already in, and as soon as the big mills and lathes needed for machining the turbines can be installed, the shop can swing into production."

The $3,000,000 expansion of the gear shop facilities at Lynn was started last Spring, according to the announcement. Construction started then on the two new shop additions will nearly double G-E's facilities for manufacturing reduction gears when completed early next year.

During the last "war period" from 1915 to 1922, General Electric producted propulsion equipments for 300—2500-horsepower single-screw cargo ships and forty 27,000-horsepower destroyers.

Turbines are used because they are the most efficient prime mover known; and gears because the high revolving speeds at which turbines operate best must be reduced to the relatively slow speeds at which a propeller will bite into the water at maximum efficiency, according to G-E.

About 12 to 18 months are required for building the turbines and gears which make up the propulsion equipments for the larger Navy ships and testing them before they are sent to the shipyards for installation.

With completion of its present expansion program, General Electric will be manufacturing propulsion equipment for naval

Continued on Page 26

CARRIER OFFERS

4 Ways to Make Every Day a Good Day!

1 FOR STORES OR SMALL SPACES

SELF-CONTAINED WEATHERMAKER

This handsome unit in its all-enclosing cabinet is available in 3 sizes, from 3 to 6.1 tons cooling capacities. Ideal for modernization, it needs but 3 connections, no building alterations. Quiet, economical, easily moved.

2 FOR A SINGLE ROOM

ROOM WEATHERMAKER

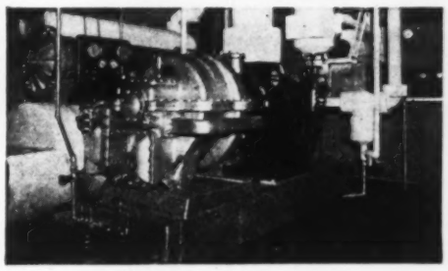
Quickly installed. Plugs into any electric socket—no other connection needed—cools, dehumidifies; shuts out noise and dust; ventilates. Heats and humidifies if desired.

3 FOR LARGER SPACES OR A SINGLE FLOOR

SELF-CONTAINED WEATHERMAKER
in new large sizes

4 sizes from 4 to 17 tons cooling capacities now bring true air conditioning to spaces formerly requiring larger, permanently installed equipment. Easily installed in or adjacent to the space to be conditioned.

4 FOR A COMPLETE BUILDING



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Carrier offers central plant equipment to meet every conceivable need. Carrier Centrifugal Refrigeration for cooling economy . . . Carrier Evaporative Condenser for water economy . . . Carrier Technique for dependable, low-cost performance.

FOUR general types of Carrier Equipment solve any air conditioning problem for stores, factories, hotels, or office buildings . . . for any type of commercial or industrial structure . . . for a single room, a separate floor, or a complete building . . . for summer comfort or year 'round use.

You specify continued comfort and continued profits when you specify Carrier Air Conditioning. Carrier offers proved dependability backed by 38 years of experience in 99 countries of the world.

Next time you have an air conditioning problem—*any* kind—call the Carrier Representative. He'll be glad to work with you—help you plan an installation that does justice to *your* plans . . . that will pay its own way in performance, economy and satisfaction. Remember, when you call Carrier, you call air conditioning by its *first name.*

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First Name

—Call CARRIER

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CARRIER CORPORATION Desk 12L
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Please send me complete information on
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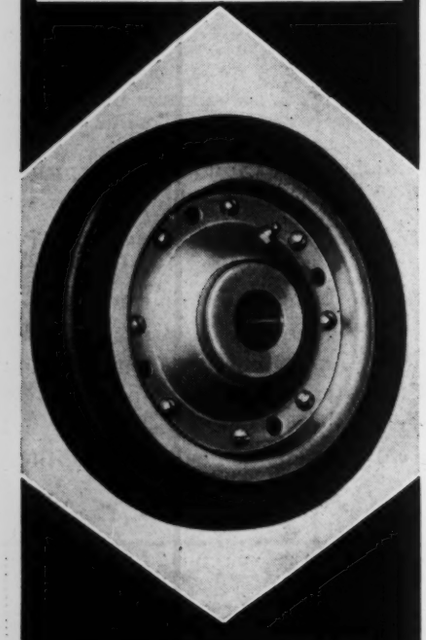

DARNELL
Casters & Wheels

• Keep Informed . . .

Continued from page 24

vessels at three of its largest Works: Schenectady, Erie, and Lynn. Auxiliary sets to provide power for numerous requirements on shipboard are manufactured at the Lynn factory, as well as complete propulsion equipments for merchant ships and the Navy "Fleet's Train," made up of service vessels for the combat ships, mine layers, mine sweepers, and tugs.

Coal Handling Equipment for Chicago Commonwealth-Edison

Negotiations have just been concluded whereby the Robins Conveying Belt Co., of Passaic, N. J., has been successfully favored with a contract through Sargent and Lundy, Consulting Engineers of Chicago, to design and furnish coal handling equipment for the Commonwealth-Edison Company's plant located on the Chicago River, Chicago, Ill.

This contract, one of the largest ever received in the history of the Company, is well over the half-million dollar mark.

The equipment in general consists of a Gantry type Bridge for unloading and reloading coal barges in conjunction with a storage and reclaiming system. A reversible Conveyor System includes a Traveling Stacker and a Traveling Barge and Car Loading Boom, an auxiliary Traveling Tower Crane with cantilevered Trolley Boom that unloads barges only and transfers coal to the Conveyor System leading to a Breaker House and Main Power Station Coal Bunkers. Two Barge Shifting Units are also included, each of which contemplates the movement of barges along an 850 foot long dock. The initial capacity of this equipment is for 800 T.P.H. of R.O.M. coal.

George W. Curtis Heads Timken Milwaukee Division

Officials of The Timken Roller Bearing Co. this week announced the appointment of George W. Curtis as the Milwaukee Division Manager. Industrial and Automotive bearing sales as well as Alloy Steel sales activities of this division will be under his supervision.

Since Mr. Curtis' graduation in 1920 from Carnegie Institute of Technology he has served in important engineering and sales capacities at Canton, Ohio, and Pittsburgh, Pa. Upon his transfer from Pittsburgh to Milwaukee in 1930 he was made District Manager of the Industrial Division in which position he has become widely known for his work in the application of Timken bearings to all types of automotive, agricultural and industrial equipment and also for his contribution to the design of power transmissions.

• LATEST CATALOGS

Procedures for Welding All Metals Given in New Lincoln Bulletin

The Lincoln Weldirectory, published by The Lincoln Electric Co., Cleveland, Ohio. 58 pages, 8½ x 11 inches, 165 illustrations including photos and drawings, cover—printed in two colors. Procedures for producing all types of welds in mild steel, for welding all metals used to any extent industrially and for applying surfacing metal to meet any type of wear-action in service, are given in this new bulletin just received from The Lincoln Electric Co., Coit Road & Kirby Ave., Cleveland, Ohio.

"The Lincoln Weldirectory," gives complete procedures for the following: flat, vertical or overhead welding of mild steel; single or multiple pass welding and for poor fit-up in mild steel; flat welding of fillet welds in mild steel; flat welding of deep-groove joints in mild steel; flat welding of deep-groove joints in high tensile steels; general welding of high tensile steels; welding of light-gauge steel, 18-8, 25-12, 18-8 SMO and 25-20 stainless steels, 4-6 chrome steels, chromium molybdenum, nickel chrome alloys, high manganese steel cast iron, aluminum, bronze, brass and copper; for surfacing to produce moderate shock and abrasion-resisting welds; rolling or sliding abrasion-resisting welds; and for making tool steel cutting edges on ordinary steel and rebuilding worn tools and dies.

The procedures, which cover all types of welding, include: recommended current ranges and arc voltages; suggestions regarding arc length, polarity of welding current, distance to hold electrode from work, cleaning beads, welding up or down, use of wide and narrow beads, peening to increase hardness, quenching, weaving the electrode, etc. Properties of welds produced in various metals are given and typical welding applications are illustrated.

A valuable feature of the new bulletin is a chart serving as a guide for selection of electrodes for various applications, in addition to a discussion of flat, convex and concave beads. An additional feature, which will be found helpful to all users of welding, is a 2-page illustrated section giving information and pointers on the proper use of modern shielded arc welding. A 10-page section covers the subject of surfacing with arc welding and includes a chart for selection of elec-

Continued on Page 28

PROFESSIONAL SERVICE

In ALL BRANCHES of the ENGINEERING FIELD

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Weld Testing—Qualification of Operators—Supervision—Inspection—Research.
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Pittsburgh Testing Laboratory, Pittsburgh, Pa.

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140 S. Dearborn St., Chicago, Ill.

RATE Announcements under this heading in MECHANICAL ENGINEERING are inserted at the flat rate of $1.25 a line per issue, $1.00 a line to A.S.M.E. members, minimum charge, three line basis. Uniform style set-up. Copy must be in hand not later than the 10th of the month preceding date of publication.

"PLANETORQUES MUST BE SAVING A LOT OF MAINTENANCE MEN MANY HEADACHES"
"...YES, AND THEY'RE SAVING ON REPAIR COSTS FOR PLANT OWNERS, TOO"

Philadelphia LIMITORQUE CONTROL operates all types of valves, etc., safely, economically, from convenient stations.
Philadelphia WORM GEAR SPEED REDUCER right angle drives—vertical or horizontal. Wide range of ratios and horsepowers.
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● Now you can protect your agitators, mixers, conveyors and other equipment from damage caused by jamming or becoming overloaded. Those repair costs can be cut out, production delays eliminated and delivery dates met. How?...by driving this equipment with a Philadelphia PlaneTorque MotoReduceR. All Philadelphia MotoReduceRs, both horizontal and vertical, can be supplied with the PlaneTorque safety feature. It automatically and instantly shuts off the motor when the load exceeds a predetermined value. Then when load is removed, unit can be started without re-setting. Remember, PlaneTorque provides this unfailing protection to machinery and driving mechanism alike. Write us today for full details.

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Large industrial firm engaged in manufacture of packaging machinery for food industry desires to employ college trained mechanical engineer who has had or now has executive position preferably in engineering, development of new equipment and production supervision also general business experience, as Assistant to President. Duties would consist of contact work with company personnel and customers. Must have good personality, be original thinker, and have possibilities for further advancement in administrative work. Preferable age 33 to 40. All applications will be kept confidential and will be examined only by Company President. Must be willing to live in Central East.

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care of "Mechanical Engineering."

Polaroid*... Photoelastic Polariscope for Stress Determination

To the machine designer, photoelastic stress analysis is not only of value in the verification of calculations based on theoretical solutions, but also in the solution of problems where theoretical analysis is not available. Where weight and space must be conserved actual stress distribution is more important than stress indicated by theoretical analysis.

In the new model polariscopes of 4¼" and 6¼" clear aperture, the parallel beam is collected by a rear element and condensed through a three component lens of the Cooke system. In the new larger units (8¼" and 10" aperture) a four component lens of the Omnar system is used. In both cases, *the image is sharp throughout the field, free of aberration, astigmatism and distortion.*

Literature of new model polariscope now available

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**T. M. Reg. U.S. Pat. Off. by Polaroid Corporation*

• Keep Informed . . .

Continued from page 26

trodes for particular applications, together with detailed procedures for this important branch of welding. Arc welding accessories are illustrated and described in 8 pages of the bulletin.

Of value to all users of welding, "The Lincoln Weldirectory" is available on request from The Lincoln Electric Co., Cleveland, Ohio.

Furnace Pressure Control

To describe important new features of their Furnace Pressure Control system, which has just been extensively redesigned, the Leeds & Northrup Co. has issued a 12-page catalog—"Furnace Pressure Control for Metallurgical and Other Industrial Furnaces."

Fully illustrated, this booklet presents for the first time an L & N industrial furnace pressure controller which has its mechanism housed in a flush-mounting, instrument-type case . . . with a built-in selector switch, push-button station and handy control-setting device. The catalog shows features said to enable the user to obtain exactly the sensitivity his particular furnace conditions require. Details of design and construction, which minimize maintenance, are described . . . along with a compact control panel on which the controller and all accessories, except drive-unit, are mounted and fully wired at the factory.

For a copy of this publication, simply address Leeds & Northrup Co., 4934 Stenton Avenue, Philadelphia, Pa. Ask for Catalog N-01A-600.

Technical Bulletin 11-C

The Babcock & Wilcox Tube Co., Beaver Falls, Penna., has just issued Technical Bulletin 11-C, Specifications for Seamless Tubular Products. The bulletin contains specifications established for carbon steel and alloy steel tubes by the American Society for Testing Materials and The Association of American Railways, and specifications established by The Babcock & Wilcox Tube Co. for high chrome and stainless alloy tubes.

The specifications cover the manufacture, finish and workmanship, chemical and physical properties, tests, and permissible variations in weights and dimensions of tubes and pipe.

A limited supply is available for distribution to executive departments of seamless tubing users. Please write for copies on your company letterhead.

New Booklet on Pumps and Pump Parts

A new illustrated booklet containing comprehensive information on pumps and pump parts, published by The International Nickel Co., of 67 Wall Street, New York, N. Y., has just come from the press.

This 16-page folder, "Practical Pumping Problems and How They Are Solved," discusses in detail the uses of Monel, "K" Monel and "S" Monel for pump parts in applications where there is need for high resistance to corrosion, wear, pitting, or scoring. This includes different types of pumps, such as reciprocating, centrifugal, and rotary pumps.

Part of the book is devoted to a review of case histories. Complete performance data is given on pumps in various applications which suggest how sizeable savings can often be made in maintenance and replacement costs. Much attention is given to the choice of suitable materials for pumps handling a variety of corrosives in a wide range of industries, including power, chemical, municipal water supply, processing, railroad, steamship operation, and other diversified fields.

The booklet, which is of a semi-technical nature, was prepared in collaboration with S. A. Tucker and F. A. Annett, Associate Editors of "Power," and is being distributed without charge.

Simplified Load Computation Manual

The Marlin-Rockwell Corporation of Jamestown, N. Y., has issued a Load Computation Manual which is exceptionally simple. This manual is so easy to use that it enables any engineer or draftsman to figure bearing loads.

Engineers and designers who are frequently called upon to compute loads will find this Manual not only a time saver, but a great aid to accuracy. 68 pages of engineering data, basic formulas, computation methods, etc.

COMING MEETINGS AND EXPOSITIONS

For the next three months

DECEMBER

2–4	American Institute of Chemical Engineers, 33rd Annual Meeting, St. Charles Hotel, New Orleans, La.
2–6	The American Society of Mechanical Engineers, Sixty-first Annual Meeting, Hotel Astor, New York, N. Y.
2–6	American Society of Agricultural Engineers, Fall Meeting, Hotel Stevens, Chicago, Ill.
4–6	The American Society of Refrigerating Engineers, 36th Annual Meeting, Hotel Commodore, New York, N. Y.
4–6	National Research Council, Highway Research Board, 20th Annual Meeting, National Academy of Sciences, Washington, D. C.
5–6	The Society for the Advancement of Management, Annual Conference, Pennsylvania Hotel, New York, N. Y.
5–6	American Management Association, Insurance Conference, Palmer House, Chicago, Ill.
17	Institute of Aeronautical Sciences, Wright Brothers Lecture, New York, N. Y.
27–Jan. 2	American Association for the Advancement of Science, Bellevue-Stratford Hotel, Philadelphia, Pa.

JANUARY, 1941

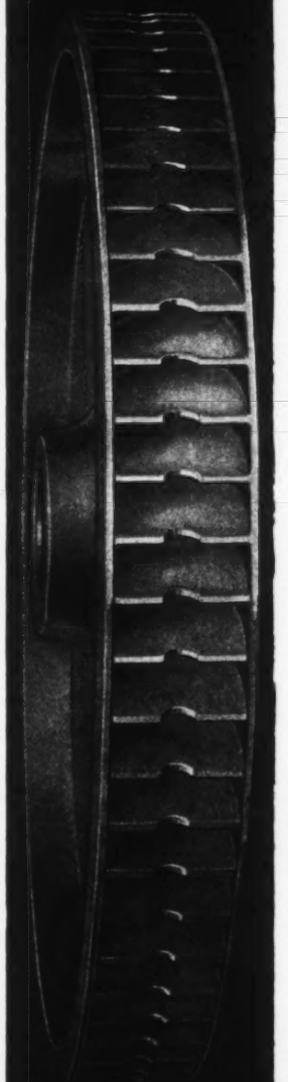
6–10	Society of Automotive Engineers, Annual Meeting and Engineering Display, Book-Cadillac Hotel, Detroit, Mich.
15–18	American Society of Civil Engineers, Annual Meeting, Waldorf Astoria New York, N. Y.
23	National Industrial Conference Board, Members' and General Session, Waldorf Astoria, New York, N. Y.
27–29	American Society of Heating and Ventilating Engineers, 47th Annual Meeting, Hotel Muehlebach, Kansas City, Mo.
27–31	American Institute of Electrical Engineers, Winter Convention, Bellevue-Stratford, Philadelphia, Pa.
29–31	Institute of the Aeronautical Sciences, Ninth Annual Meeting, Columbia University, New York, N. Y.

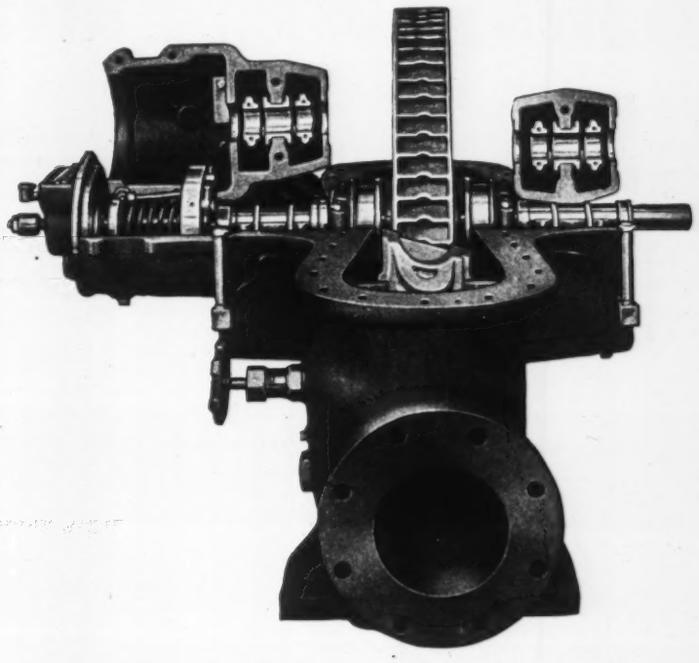
FEBRUARY

6–7	Engineering Institute of Canada, 1941 Annual Meeting, Hamilton, Ont., Canada
17–20	American Institute of Mining and Metallurgical Engineers, Annual Meeting, Hotel Commodore, New York
17–20	Technical Assoc. of the Pulp and Paper Industry, Annual Meeting, Hotel Roosevelt, New York
27	National Industrial Conference Board, Members' and General Sessions, Hotel Waldorf-Astoria, New York

For Calendar of Coming A.S.M.E. Meetings see page 932 in the editorial section

TERRY





ROTOR AND BUCKETS ALL IN ONE PIECE

In the Terry Turbine the wheel is made from a single forging of special composition steel. The buckets are milled directly in the wheel, there are no parts to become loose or work out, such construction makes for long life and low maintenance.

This and many other features of Terry Wheel Turbine design are described in our Bulletin S-116. A request on your business letterhead will bring a copy.

T-1138

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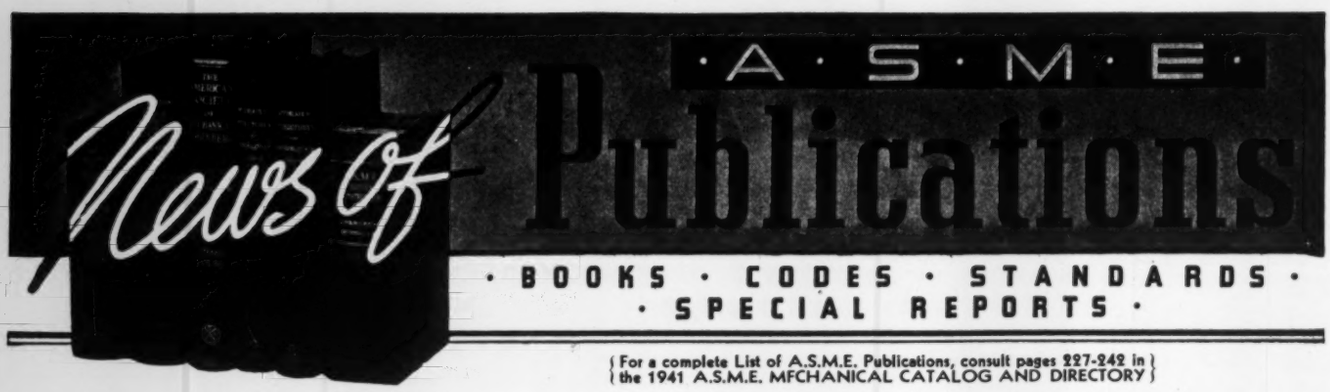

{ For a complete List of A.S.M.E. Publications, consult pages 227-242 in } { the 1941 A.S.M.E. MECHANICAL CATALOG AND DIRECTORY }

HERE THEY ARE . . . The 1940 Codes for the construction of boilers and other pressure vessels, materials, existing installations, inspection, maintenance, and operation.

POWER BOILER CODE

Including Rules for Inspection

The rules in this Code apply to the following equipment: 1) boilers for stationary service, 2) piping connections up to and including the valve or valves as required by the Code, and 3) superheaters, reheaters, economizers, and other pressure parts connected directly to the boiler without intervening valves.

In addition to the construction rules, the Code describes in detail the various methods of calculation, and presents tables of approved dimensions. Illustrating the rules are numerous diagrams, charts, and examples. The inspection rules cover new and installed boilers, as well as material.

1940 Edition will be published in December **$2.25***

SPECIFICATIONS FOR MATERIALS

This Section defines the important materials to be used in the construction of boilers and pressure vessels and gives the requirements for their chemical composition, tensile properties, annealing, heat treatment, tests, marking, inspection, etc. Of the fifty-seven specifications here published, 13 cover boiler steel plates and rivets, 6 are for steel castings, 12 apply to steel tubes, pipe, and steel bolting materials; 3 are for wrought iron, 2 for iron castings, and 15 for nonferrous metals.

1940 Edition published November 1940 **$2.00***

MINIATURE BOILER CODE

These rules apply to fired pressure vessels which do not exceed 16″ inside diameter of shell, 42 in. over-all length of outside to outside of heads at center, 20 sq ft water heating surface, and 100 lb per sq in. maximum allowable working pressure. Besides the detailed construction rules the Code presents a comprehensive set of rules for the qualification of welding procedure and welding operators.

1940 Edition published November 1940 **65¢***

UNFIRED PRESSURE VESSEL CODE

Within the 150 pages of this Code are the rules for the construction of pressure containers, including vessels subjected to external pressure, and containers for gases or liquids at from 10F to −150F. Supplementing the construction rules are recommendations for hydrostatic tests, computing shell openings, bolted flanged connections, and qualifications for welding process and operators.

1940 Edition will be published in December **$1.50***

SUGGESTED RULES FOR CARE OF POWER BOILERS

This Code provides operators of steam boiler plants with a simple, practical set of rules for routine operation, operating and maintaining boiler appliances, inspection, and the prevention of direct causes of boiler failures. Also included are recommendations for feedwater analysis, treatment, and control.

1940 Edition published September 1940 **$1.00***

BOILERS FOR LOCOMOTIVES

These recommendations are for the selection of materials, thickness of plates and tubes, allowable working pressure, joints, stayed surfaces, riveting, safety valves, fittings, and stamping.

1940 Edition will be published in December **55¢***

LOW-PRESSURE HEATING BOILER CODE

The steel and cast iron boilers for which these rules have been formulated are to be used exclusively for low-pressure steam heating, hot water heating and hot water supply. Recommendations cover ultimate strength of materials, minimum thickness of plates and tubes, joint efficiency, stayed surfaces, supports, setting, installation, fittings, welding, etc.

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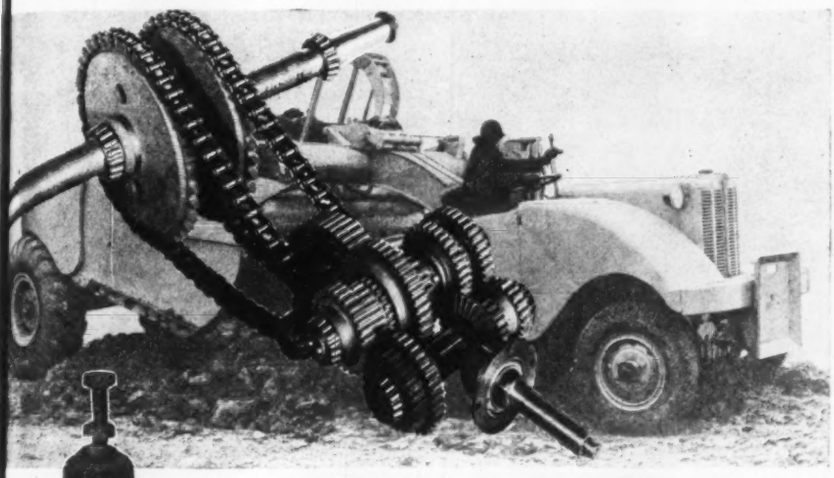
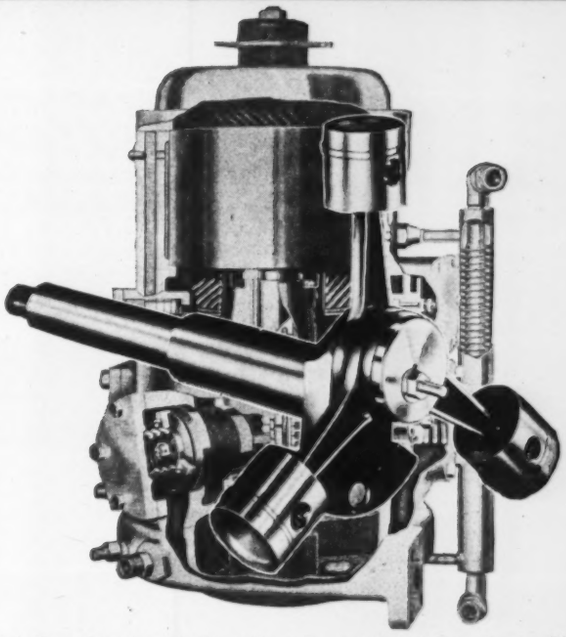
The specific combination of "QUALITY ADVANTAGES" required for any part

IS OBTAINABLE IN Forgings



The gears in this Koehring High Speed Tractor Transmission are forgings in which the grain structure and fiber formation of the metal has attained its maximum refinement and toughness, thereby providing plus strength and endurance.



This forged steel, perfectly balanced, crankshaft insures the trouble-free operation of Chrysler Airtemp Air-Conditioning Units. The secret of Airtemp compactness is in this radically new and extremely efficient radial compressor of which this forged steel crankshaft is the principal operating part, and must possess high fatigue resistance.

This cut-away view of "Servo" Mechanical Governor, manufactured by the King Seeley Corporation, shows operating fork, weight carrier, weights and lever, all of which are forgings. These parts must possess an exact degree of hardness and toughness which is obtainable in forgings, after heat treatment, in the exact degree desired.

CHECK the "quality advantages" required for each part with those offered by forgings. There are no compromises with quality necessary in using forgings. Because of plus strength in lighter sectional thicknesses, you can safely achieve a reduction of deadweight, and this advantage may be combined with such other "quality advantages" as uniformity of physical properties, low machining costs, welding adaptability. Any one of several "quality advantages" of forgings may become the primary consideration for using forgings, in which case you will get a secondary group of "quality advantages" because they are inseparable from the primary advantage. "Quality advantages" which are not otherwise available are usually obtainable in forgings.

In forgings, plus tensile and torsional strength is obtained through controlled grain flow and distribution of metal, rather than by metal bulk. Forging kneads metal into a dense mass of flawless strength—strength that is achieved through a concentration of grain structure and fiber formation at points of greatest shock or strain, thereby providing high fatigue resistance and assuring dependable performance over longer periods of use. Forgings are formed to close tolerances in dies that assure uniform size and shape, thereby reducing machining cost because there is no bulk of excess metal to remove, while unusual freedom from concealed defects avoids loss from rejections. Consult a competent forging engineer about the various combinations of "quality advantages" that are obtainable in forgings.

7 "QUALITY ADVANTAGES" OF FORGINGS:

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2. **Uniformity of Physical Properties:** obtainable in forgings in the exact degree desired.
3. **Weight Reduction:** through plus strength and lighter sectional thicknesses.
4. **Welding Adaptability:** widest range for fabricating complicated parts from two or more forgings.
5. **Lower Machining Costs:** forgings shaped in closed dies require a minimum of machining and finishing.
6. **Safety:** through freedom from concealed defects.
7. **Endurance:** forgings provide high fatigue resistance which insures dependable performance over longer periods of use.

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The Standards COLUMN

News of Interest to Manufacturers

Standards of Accuracy for Engine Lathes

FOR many years builders of engine lathes, members of the National Machine Tool Builders' Association, have been at work on a standard method of establishing limits of accuracy on various types of lathes. The need for setting up such standards was long felt because of wide variations in tolerances specified by different purchasers.

In the past each lathe manufacturer has established limits of accuracy to which his own lathes were built and the changes made to meet differing customers' specifications frequently caused confusion in both manufacturing and inspection.

Six years ago the members of this group appointed a committee to investigate this subject and to present their recommendations in the form of standards that would be acceptable to all lathe manufacturers and to users. The final limits now being established are the results of numerous meetings and discussions of this subject. Mr. Henry C. Pierle, Secretary, The R. K. LeBlond Machine Tool Company, Cincinnati, Ohio, is chairman of the NMTBA Committee on Standards of Accuracy for Engine Lathes.

This proposed American Standard gives the maximum allowable error for the different alignments. Many lathes will be built where the error is well within these limits so that any purchaser of an engine lathe may be assured of an accuracy equal to or even better than that shown.

The standards established cover three types of lathes:

A—Tool Room Lathes
B—Engine Lathes, 12 to 18 in. swing inclusive
C—Engine Lathes, 20 to 36 in. swing inclusive

Every mechanical man realizes the cost of obtaining that last one-tenth of a thousandth in accuracy and no one would expect the same limits on a heavy 36 in. engine lathe that apply to a 12 in. precision tool room lathe. Limits were established, therefore, to take care of work done on these different types of machines.

The proposed standard has now been submitted to the American Standards Association for review and approval as an American Standard. When approved the lathe builders hope that it will find universal acceptance by the users of lathes in industry and that, instead of setting up limits of their own in their specifications, they will simply incorporate the provision that the "limits of accuracy shall conform to the American Standard as developed by the National Machine Tool Builders' Association."

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Supplementing this general index is a Classified Specialty List of a number of the Consultants advertising their specialized lines of practice.

This Professional Service Section in the New 1940 A.S.M.E. Membership List should be helpful in the selection of Consultants.

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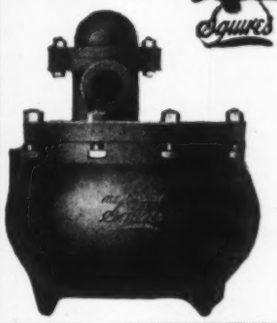

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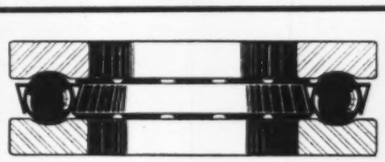

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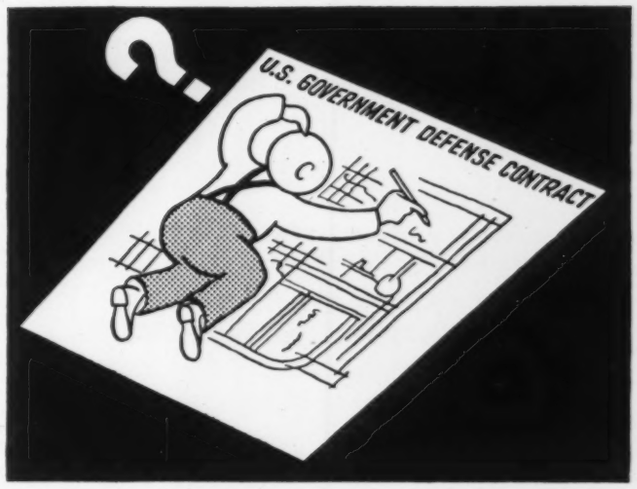

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The FUEL FACTOR

-a basic consideration in future tractor design

SINCE the light-weight, rubber-tired high compression tractor was introduced about five years ago, the number of tractors on American farms has increased almost fifty per cent. The growing use of tractors on smaller farms has in a large measure been made possible by the adoption of the high compression principle and the increasing use of gasoline instead of kerosene or distillate as tractor fuel (Fig. 1). For high compression engines, able to take advantage of better fuels, give increased power without additional weight and permit the design of compact, convenient, inexpensive tractors. Through the use of good gasoline and high compression, farmers are able to buy *more horsepower at lower cost.*

Thus in tractor engines, as in automobile, truck and aviation engines, each improvement in fuel opens up new opportunities for increasing power and efficiency. In fact, the consideration of the "fuel factor" is today one

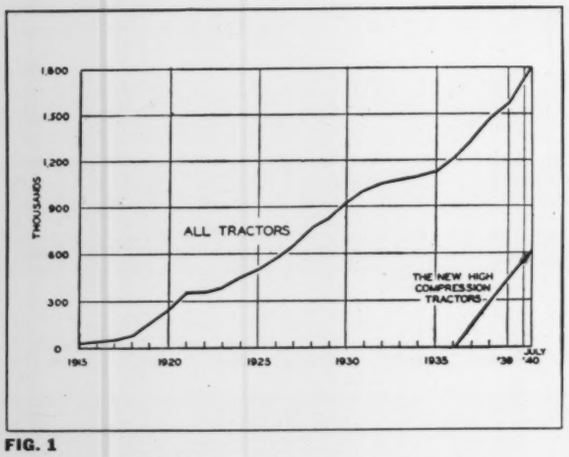

FIG. 1

THE RAPID INCREASE, starting in 1936, in the total number of tractors on farms in this country is due principally to the introduction of the small, high compression, automotive-type tractors. There are now 600,000 of these tractors in use, about one-third of the total number of all types. Data on total number of tractors is from the U. S. Dept. of Agriculture; that on the new type tractors from estimates made by manufacturers to National Petroleum News.

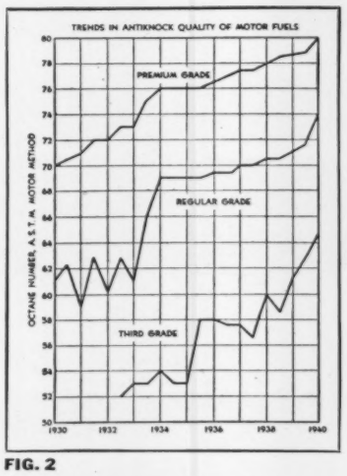

FIG. 2

OCTANE NUMBERS of automotive fuels have risen steadily over the past ten years. It is interesting to note that the regular gasoline being marketed today is superior in anti-knock quality to the premium gasoline of 1933.

of the most important elements in the long-range planning of all automotive equipment.

Designers of engines for tractors, as well as for automobiles and commercial vehicles, should keep the following fuel trends constantly in mind:

Higher anti-knock levels. The steady rise in anti-knock values is of prime importance because of its close relationship to permissible compression pressure. Farmers, as well as commercial vehicle operators, are quick to take advantage of the increased economy, performance and flexibility made available by higher anti-knock fuels (Fig. 2).

Improved fuel structure. For some time it has been known that motor fuels are made up of hundreds of individual hydrocarbons. These differ from one another in their properties; each has its own chemical structure, specific gravity, boiling point and anti-knock value. Refiners today can produce fuels containing higher proportions of the more desirable types of hydrocarbons.

Use of anti-knock compounds. When added to fuels produced by some of the new refining processes, tetraethyl lead gives an improvement far greater than when added to stocks now generally available. The increase in octane number resulting from the addition of tetraethyl lead will influence the refiner in his choice of refining processes, and it should be given equal consideration by the tractor and automotive engineer in broad plans for future engine development.

Each step toward more efficient tractors, automobiles, trucks, buses and aviation engines invariably involves the solution of new problems, problems not only of fuels and engine design, but of engine parts, materials and lubricants. We of the Ethyl Gasoline Corporation believe that these problems can best be solved by coordinated, intensive research on the part of the tractor, automotive and petroleum industries.

At our laboratories in Detroit and San Bernardino we are actively cooperating with engine designers in making the best possible use of tomorrow's fuels and with fuel refiners in producing gasoline best suited to tomorrow's engines. And through our staff of field engineers we are helping the users of engines and fuels in the practical application of laboratory findings.

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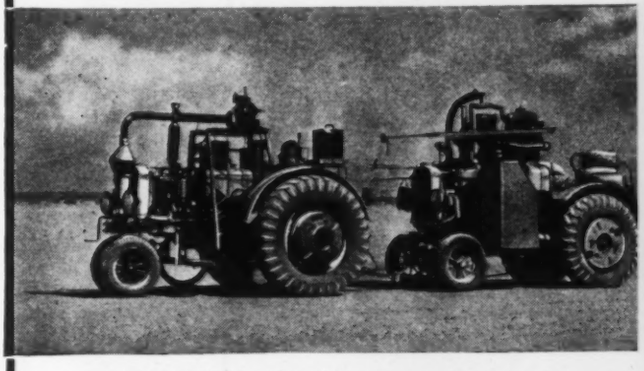
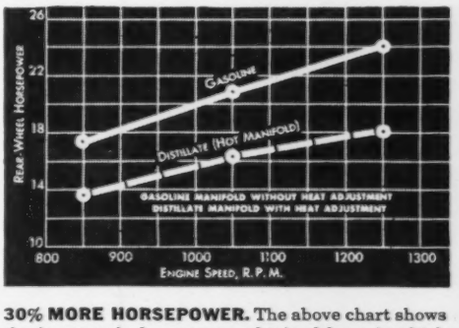
MAKING TRANSPORTATION BETTER AND MORE ECONOMICAL THROUGH RESEARCH

Here are some of the lines of research in which the Ethyl Research Laboratories are now engaged:

Application of higher compression ratios to commercial vehicles and farm tractors for more efficient utilization of today's improved fuels ★ The development of super compression engines for the utilization of tomorrow's fuels of 90 to 100 octane number ★ Supercharging of passenger and commercial vehicle engines ★ Effect of volatility on anti-knock value ★ Effects of sulfur ★ Anti-knock tests on new fuels ★ Study of the relation of lubrication to fuel and engine developments ★ Pre-ignition ★ Studies of improved ceramics and metal alloys ★ Instrumentation.



THE TRACTORS with their instrumentation pictured above were used to measure horsepower and fuel economy in field tests made at our San Bernardino laboratory under conditions simulating actual farm operations. This work is part of an extensive research program on the relation of fuel characteristics to the design and performance of tractor engines which is being conducted in our laboratories in cooperation with tractor manufacturers and fuel refiners.



30% MORE HORSEPOWER. The above chart shows the increase in horsepower obtained by using high compression and a good grade of regular gasoline in a number of recent tractor tests. Farm tractor manufacturers as well as tractor owners have been quick to recognize the fact that more power gives more productive power farming.

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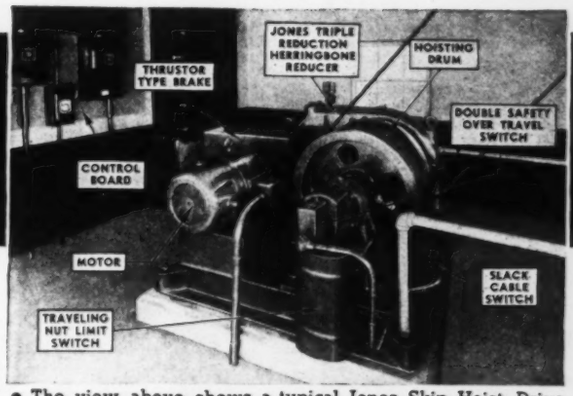
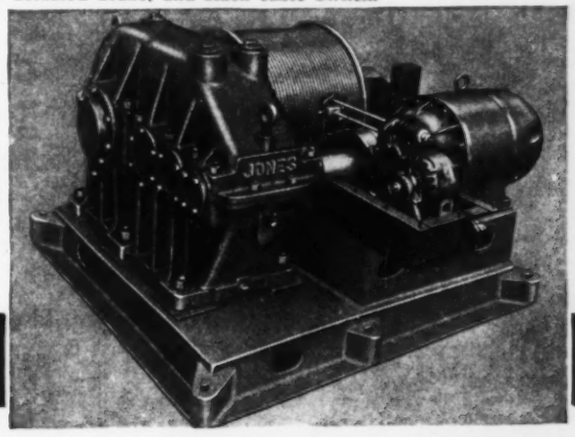


• The view above shows a typical Jones Skip Hoist Drive installation while the view below shows one of the Jones units equipped with traveling nut type limit switch, motor actuated brake, and slack cable switch.



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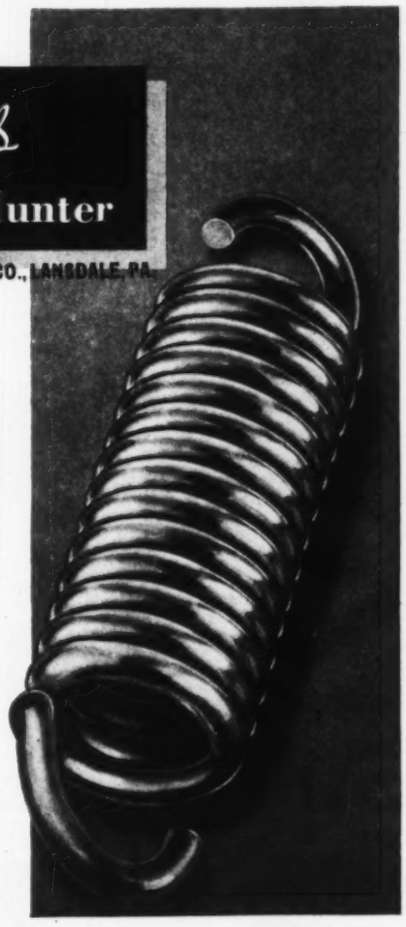

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In these annealing operations, the bases are subjected to extreme heat and heavy loads. In previous experience, the bases broke down after 50 heats—had to be rebuilt. Since rebuilding with CAREY HI-TEMP and 85% MAGNESIA, the bases are as good as new after 50 heats.

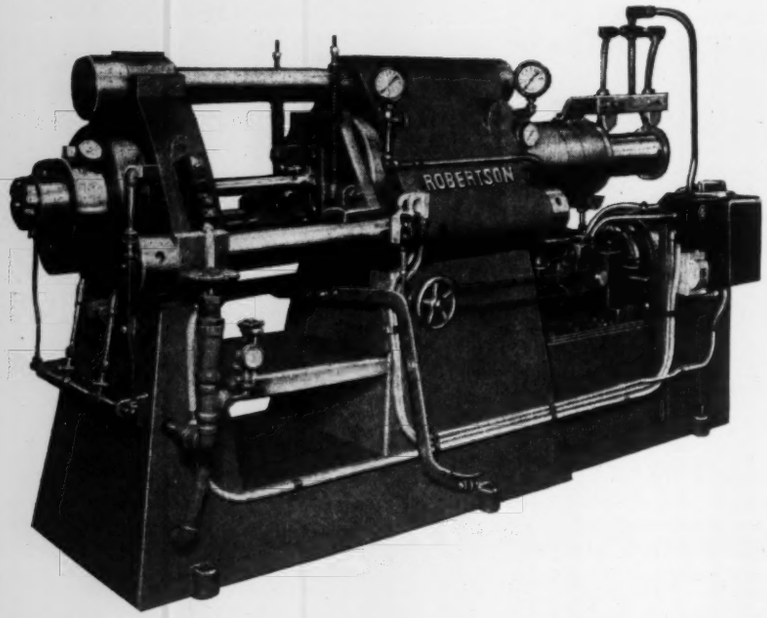
The tougher the job, the more you need CAREY Insulations. Whatever your insulation problem, put it up to CAREY. Write for Insulation Catalog—address Dept. 63.

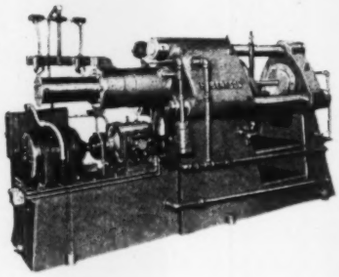
THE PHILIP CAREY COMPANY • Lockland, Cincinnati, Ohio
Dependable Products Since 1873
BRANCHES IN PRINCIPAL CITIES

NOW. . . *semi-automatic!*

Robertson proudly announces **a new feature in a horizontal extrusion press already acclaimed for its economy and efficiency in extruding miscellaneous non-ferrous alloys, lead and its alloys, solder and solder wire and flux core solder wire.** ***New finger-tip control*** **sends the press forward through the extrusion stroke and returns it to starting position . . . without any other attention! Just a touch on a button does it; a child could operate this press. Ask about it; write—**

JOHN ROBERTSON CO., INC., 121-37 WATER ST., BROOKLYN, N. Y.





ROBERTSON *Improved*

horizontal extrusion press

Every Advertiser appearing in MECHANICAL ENGINEERING believes . . . .

that his products . . . the service in them and the service behind them . . . will stand up under the most searching scrutiny of the high calibre engineers and executives comprising MECHANICAL ENGINEERING readership.

—using Tannate belting on a drive with the Rockwood base—

"ICE PLANT INCREASED CAPACITY FROM 60 TONS TO 80 TONS PER DAY—
Lowered costs 4¢ per ton!"

For the short center drive *—always correct belt tension and maximum steady output* where TANNATE-Rockwood is installed! Proof aplenty; ask to see it!

RHOADS *Founded 1702*

Tannate-Rockwood
the ideal
SHORT CENTER DRIVE

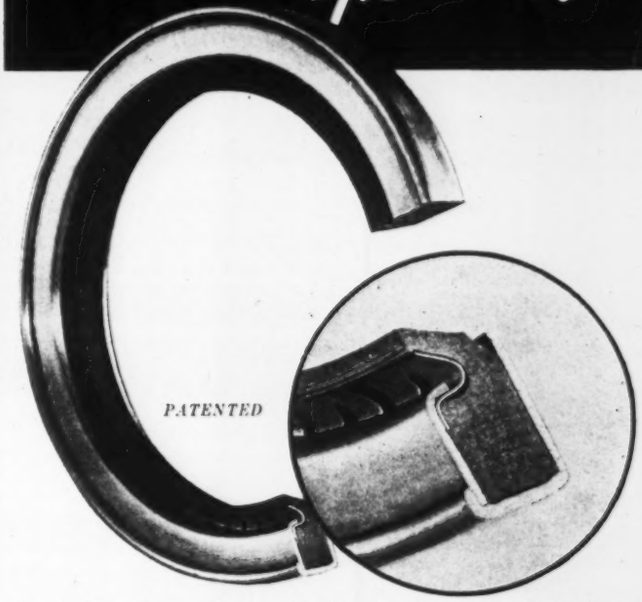
J. E. RHOADS & SONS, 35 North Sixth St., Philadelphia, Pa.
New York • Chicago • Atlanta • Cleveland

CHRISTMAS SEALS

Help to Protect Your Home from Tuberculosis

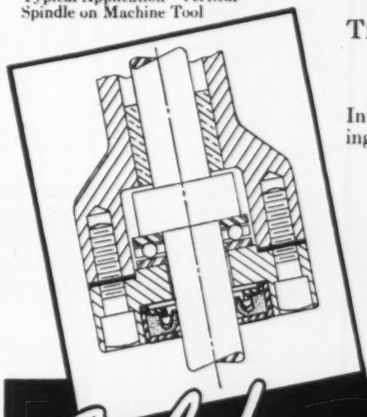
THIS OIL SEAL STANDS UP

—Does not get Soft and Flabby!



You have seen them—fighters, who seemed to have everything. But often—when the going really gets tough—you have watched them fold up, go soft. That's the way with oil seals which become soft and flabby in service. Not so with the Garlock KLOZURE Oil Seal! Made of an exclusive compound, the sealing ring of the Garlock KLOZURE *stays firm—stands up* even under the most severe conditions.

Typical Application—Vertical Spindle on Machine Tool



THE GARLOCK PACKING COMPANY
PALMYRA, NEW YORK
In Canada: The Garlock Packing Company of Canada Ltd., Montreal, Que.

Garlock KLOZURE

Representatives—Sales Agencies
Businesses For Sale
Partnership—Capital
Manufacturing Facilities

OPPORTUNITIES

Positions Open—Positions Wanted—Equipment, Material Patents, Books, Instruments, etc. Wanted and For Sale

RATES Classified advertisements under this heading in MECHANICAL ENGINEERING are inserted at the rate of 60 cents a line 50 cents a line to members of A.S.M.E. Seven words to the line average. A box number address counts as one line. Minimum insertion charge, 5 line basis, maximum 20 lines. Display matter carried in single column units of multiples of one inch a flat rate of $10. per inch per insertion. Copy must be in hand not later than the 10th of the month preceding date of publication.

POSITIONS OPEN

WANTED . . .

Supervisors for planning and production, also jig, tool and fixture designers, also first class tool makers and mechanics.

Apply—**Montreal Locomotive Works, Ltd.**
5781 Notre Dame Street East **Montreal, Canada**

SENIOR INDUSTRIAL ENGINEER WANTED

Established firm of Engineers intends to add a Senior Engineer to its industrial staff.

THE POSITION:—With a firm of Consulting Engineers that has been in business for many years; to take responsible charge of consulting jobs of an industrial nature; not a temporary position; some traveling necessary; base location in the East.

REQUIREMENTS:—Age 35-45; graduate of a recognized engineering college; manufacturing experience in the metal working industry; present minimum earning record of $6,000 per annum. Some consulting engineering experience desirable but not absolutely necessary. If these requirements cannot be filled, please do not answer this advertisement.

PLEASE SEND:—Present address; date of birth; place of birth; marital status; college attended; degree and year obtained; chronological record of experience in detail showing dates, company name, position held, duties and salary; small photograph.

GENERAL:—All answers will be considered confidential; references and present employers will not be checked until agreeable to the applicant; interviews with selected applicants will be arranged at the Company's expense.

Address CA-505, care of "Mechanical Engineering."

BUSINESS OPPORTUNITIES

MANUFACTURING RIGHTS WANTED—Independent manufacturer with complete engineering and research staff, production facilities, and international industrial sales organization wants to develop new industrial markets through new products. Write brief letter. Address CA-482, care of "Mechanical Engineering."

POSITIONS WANTED

ADMINISTRATIVE ASSISTANT—Mechanical engineer, age forty, seventeen years with large corporation, four efficiency and special assignment, twelve personal assistant to president covering all operations. Now in charge all operations medium size static company. Address CA-502, care of "Mechanical Engineering."

MACHINE TOOL ENGINEER for ORDNANCE, 25 years experience in the designing and manufacturing of gun boring and turning lathes, rifling machines, shell lathes, armor plate planing and drilling machines for U. S. Army and Navy, private industries and Foreign governments. Now employed, desires designing or manufacturing executive position with well established concern requiring specialized knowledge of machine tools for ordnance. 48 years old, in excellent health. Address CA-503, care of "Mechanical Engineering."

MECHANICAL ENGINEER—Member A.S.M.E. University Graduate, age 39, 10 years of varied, diversified experience including design, time study, stress analysis, cost reduction, experimental testing desires responsible position. Interested in power plant work, research and sales engineering. Mechanically inclined and good draftsman. Interested in connection where there is a future. Address CA-504, care of "Mechanical Engineering."

REPRESENTATIVES AVAILABLE

MANUFACTURERS AGENT established in New England, with contacts in best industrial plants, desires another high class line of engineering nature. Address CA-506, care of "Mechanical Engineering."

Use a CLASSIFIED ADVERTISEMENT *for Quick Results*

FOR SALE

HYDRAULIC COUPLING—S3—Size 18 Variable Speed Hydraulic Couplings, C. W. rotation, complete. One Coupling never has been used, is still on original skids, and in practically perfect condition. Two couplings have been used intermittently for about nine months, and in perfect working order. These couplings are offered at 25% discount for new one, and 50% for others. One or three immediately available. Prat-Daniel Corporation, Port Chester, N. Y.

SECOND-HAND COMPRESSORS, twenty tie tamping compressors, 9 type 14—11 type 20 Ingersoll-Rand Gasoline Driven, mounted on one-piece cast frame, with axles and flanged wheels for traveling on tracks; also type M-I Air Guns. For particulars write to E. A. Jones, 143 Liberty St., New York, N. Y.

EMPLOYMENT AGENCIES AND SERVICE BUREAUS

EXECUTIVES $2,400 — $25,000

This reliable service, established 1927, conducts confidential negotiations for high grade men who either seek a change, or the opportunity of considering one, under conditions assuring, if employed, full protection to present position. Send name and address only for details.

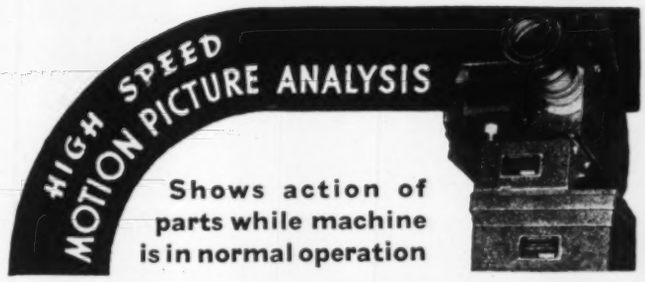
JIRA THAYER JENNINGS
Dept. D—9 Center Street, New Haven, Conn.

E. G. Stroud, Member A.S.M.E., President The Cleveland Engineering Agency Co., 219 Huron-Ninth Building, Cleveland, Ohio, has for 30 years been engaged in technical placement work. Employers wishing to engage Executives, Engineers, Designers, Draftsmen or other technical men are invited to use this service. Applicants available should write for blank and list of opportunities.

SALARIED POSITIONS
$2,500 to $25,000

This thoroughly organized advertising service of 30 years' recognized standing and reputation, carries on preliminary negotiations for positions of the caliber indicated above, through a procedure individualized to each client's personal requirements. Several weeks are required to negotiate and each individual must finance the moderate cost of his own campaign. Retaining fee protected by refund provision as stipulated in our agreement. Identity is covered and, if employed, present position protected. If your salary has been $2,500 or more, send only name and address for details. R. W. Bixby, Inc., 115 Delward Bldg., Buffalo, N. Y.

It will pay you to watch the announcements on this page for an opportunity that you may be looking for or one that may be of interest to you.



See what is happening in your high speed machines. Can be used in mechanical, electrical or chemical field. • Pictures taken at speeds up to 2500 frames per second • Time to one one-thousandth of a second on every frame of the film.

WALTER S. CALVERT 2 EAST 23RD STREET NEW YORK CITY

MECHANICAL ENGINEERING
November, 1940 CARD INDEX Vol. 62, No. 11

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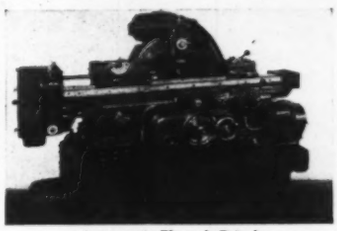
Universal Turret Lathes Fay Automatic Lathes
Automatic Thread Grinders

Projection Comparators for Inspection and Measurement

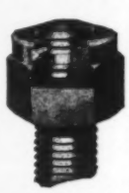


Automatic Thread Cutting Dies and Chasers

Automatic Thread Grinder

JONES & LAMSON MACHINE CO.
SPRINGFIELD, VERMONT, U.S.A.

VIBRATION-PROOF!



UNSHAKO —the NUT that can't shake loose
Reg. U. S. Pat. Off.

The self-energizing locking ring springs to life as soon as any vibration—no matter how severe—tries to unwind the "Unshako" and positively prevents it.

Order "Unshako", this neatly ingenious and unfailing protection against costly troubles caused by ordinary nuts shaking loose.

Pat'd. and Pat's. Pending

STANDARD PRESSED STEEL CO.
JENKINTOWN, PENNA. BOX 558
BRANCHES
BOSTON • DETROIT • INDIANAPOLIS • CHICAGO • ST. LOUIS • SAN FRANCISCO

Sharp-detail Blueprints!

No fuzziness of even the finest lines when MICROTOMIC VAN DYKE rules your tracings. Long-wearing points for drafting comfort. Uniform grading for surety of your touch. *Opacity of line*—an outstanding feature by which these have become the pencils of first preference by the man at the board... Like to try a sample? What degree, please?... Eberhard Faber Pencil Company, 37 Greenpoint Ave., Brooklyn, N.Y.

MICROTOMIC
VAN DYKE

THE EBERHARD FABER DRAWING PENCIL WITH THE MICROTOMIC LEAD ... 18 DEGREES ... AND 6 ALSO WITH CHISEL POINT LEADS

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Guardian Elect. Mfg. Co. — *Kennedy & Co., Chicago, Ill.*
Hunter Pressed Steel Co. — *R. E. Lovekin Corp., Philadelphia, Pa.*
Hyatt Bearings — *Campbell-Ewald Co., New York, N. Y.*
International Nickel Co. — *Marschalk & Pratt, New York, N. Y.*
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Lincoln Electric Co. — *Griswold-Eshleman, Cleveland, Ohio*
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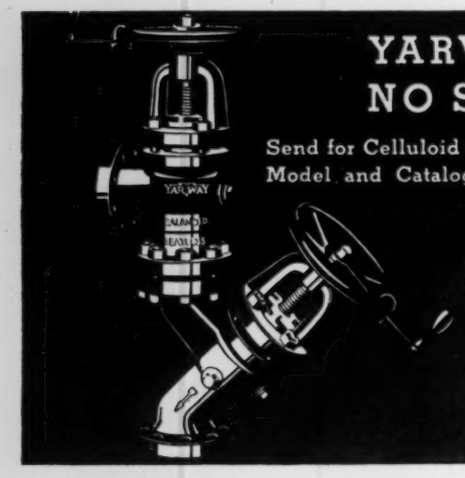
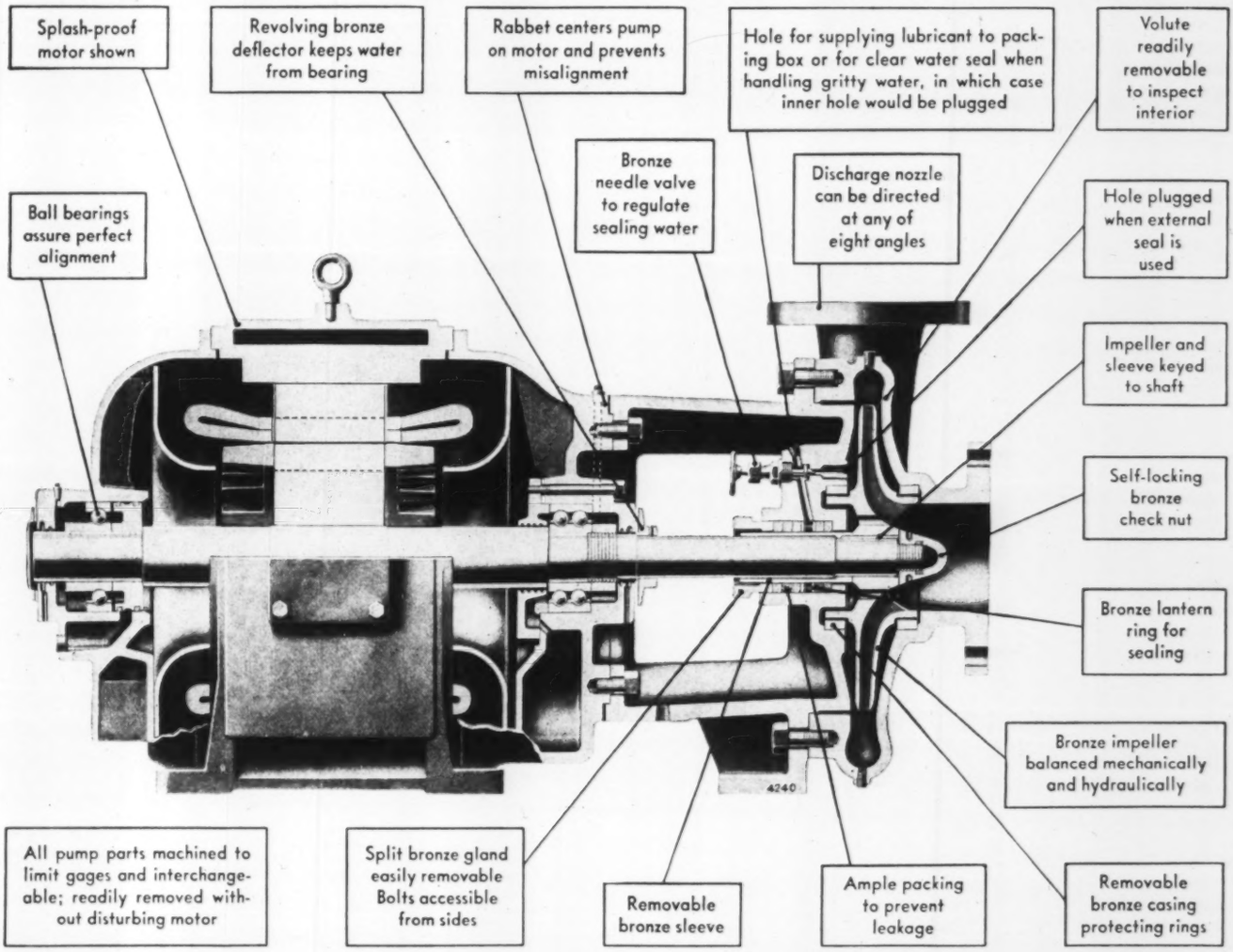
Northwestern Mutual Life Ins. Co. — *Buchen Co., Chicago, Ill.*
Ozalid Products Div., General Aniline & Film Corp. — *D. Wm. Roth Co., New York, N. Y.*
Philadelphia Gear Works — *R. E. Lovekin Corp., Philadelphia, Pa.*
J. E. Rhoads & Sons — *R. E. Lovekin Corp., Philadelphia, Pa.*
John Robertson Co. — *R. E. Lovekin Corp., Philadelphia, Pa.*
Standard Pressed Steel Co. — *R. E. Lovekin Corp., Philadelphia, Pa.*
B. F. Sturtevant Co. — *Rickard & Co., New York, N. Y.*
Taylor Forge & Pipe Works — *Kreicker & Meloan, Chicago, Ill.*
Yarnall-Waring Co. — *McLain Organization, Philadelphia, Pa.*



YARWAY SEATLESS BLOW-OFF VALVES
NO SEAT TO SCORE, CLOG, WEAR, LEAK
Send for Celluloid Working Model and Catalog A-430
More than 10,000 installations
YARWAY
YARNALL-WARING CO PHILADELPHIA, PA.

DE LAVAL MOTOR MOUNTED PUMP


Splash-proof motor shown
Revolving bronze deflector keeps water from bearing
Rabbet centers pump on motor and prevents misalignment
Hole for supplying lubricant to packing box or for clear water seal when handling gritty water, in which case inner hole would be plugged
Volute readily removable to inspect interior
Ball bearings assure perfect alignment
Bronze needle valve to regulate sealing water
Discharge nozzle can be directed at any of eight angles
Hole plugged when external seal is used
Impeller and sleeve keyed to shaft
Self-locking bronze check nut
Bronze lantern ring for sealing
Bronze impeller balanced mechanically and hydraulically
Removable bronze casing protecting rings
Ample packing to prevent leakage
Removable bronze sleeve
Split bronze gland easily removable Bolts accessible from sides
All pump parts machined to limit gages and interchangeable; readily removed without disturbing motor
4240

A highly efficient pumping unit at minimun cost.

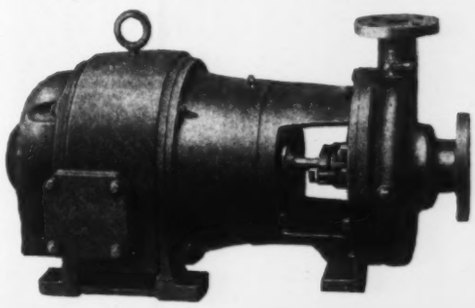
The pump is carried on the motor frame, no sub-base or special foundations are necessary. The unit can be mounted or suspended in any position.

The two ball bearings are grease lubricated.

The motor can be of any type, open, enclosed, splash-proof or explosion-proof.

Capacities 5 to 1200° g.p.m.; heads 10 to 230 ft.

Parts subject to wear renewable at small expense.



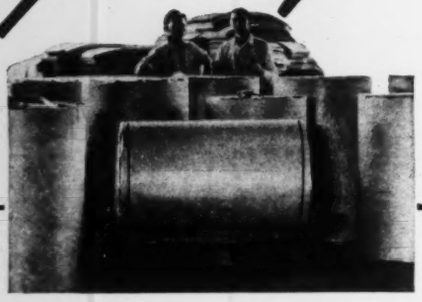
Ask for Catalog P-3705, which gives instructions for figuring piping and selecting and installing pump.

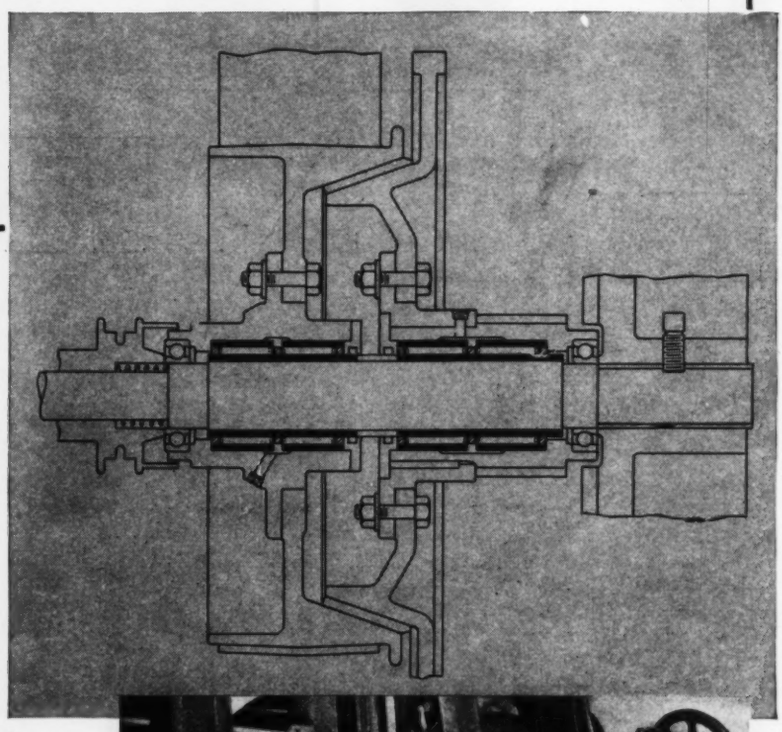
HYDRAULIC INSTITUTE U.S.A. MEMBER

DE LAVAL *Steam Turbine Co.*
TRENTON, N.J.

MANUFACTURERS OF TURBINES . . . STEAM, HYDRAULIC; PUMPS . . . CENTRIFUGAL, PROPELLER, ROTARY DISPLACEMENT, MOTOR-MOUNTED, MIXED-FLOW, CLOGLESS, SELF-PRIMING, CENTRIFUGAL BLOWERS and COMPRESSORS; GEARS . . . WORM, HELICAL and FLEXIBLE COUPLINGS

For Faster PRODUCTION





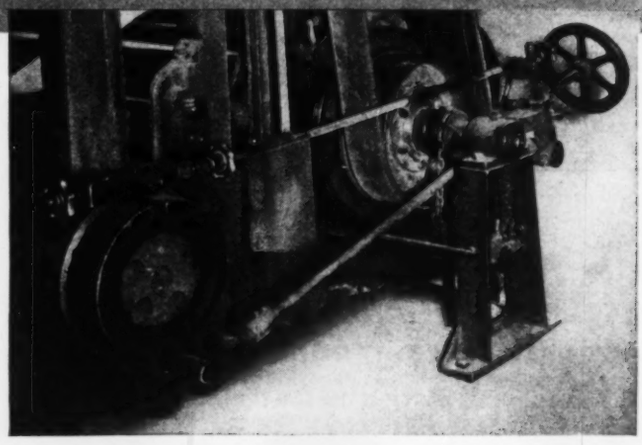
MISSISQUOI REWINDER SPEEDED UP, FRICTION PULLEY TROUBLES BANISHED WITH SPECIAL BANTAM BEARINGS

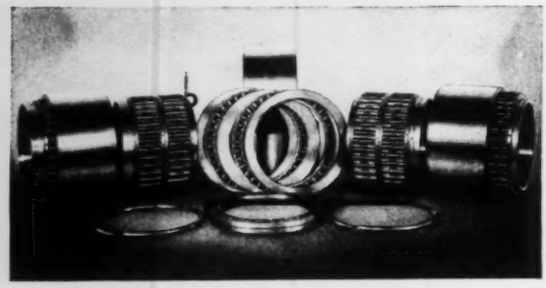
Demands for faster and faster speeds—and the elimination of costly shut-downs and outage time were two problems solved for the Missisquoi Corporation by special Bantam Radial Roller Bearings.

Let Mr. G. L. Johnston, Missisquoi's Plant Engineer, tell you the details. "These Bantam Bearings were installed in March, 1938, replacing bronze bushings, on the main friction pulley shaft of a rewinder. Since this machine was originally installed it has been necessary to operate it at considerably above its original speed and we had been constantly replacing these bushings—to say nothing of the headache of a shut-down at some of the most inopportune times. However, since these Bantam Roller Bearings had been installed this machine has never been shut down for Friction Pulley trouble, for which we are very thankful."

Here is another example of the way Bantam's background of experience in the design and manufacture of all types of anti-friction bearings can help you in securing top-notch bearing performance. Bantam Engineers will be glad to cooperate with you and with your machine builders in the selection of the right bearings for *your* requirements. For dependable, trouble-free bearing service—TURN TO BANTAM.

BANTAM BEARINGS CORPORATION, South Bend, Indiana





(*Far Left*) **BANTAM'S RADIAL ROLLER BEARINGS** of the same general type used in the Missisquoi rewinder installation find many applications in paper-making machinery where loads and speeds are high, and service demands are severe.

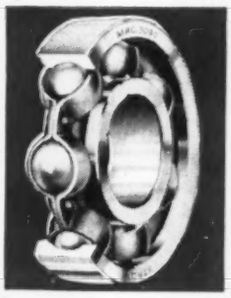
(*Left*) **BANTAM MAKES ALL MAJOR TYPES** of anti-friction bearings from tapered roller, straight roller and ball bearings in giant sizes—to the smallest of Quill Bearings. This wide experience enables Bantam to give expert, unbiased counsel in the selection of the correct bearing for any individual job.

BANTAM BEARINGS

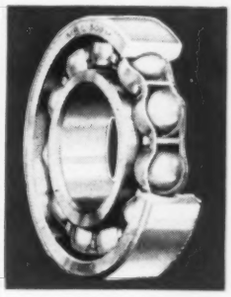
STRAIGHT ROLLER • TAPERED ROLLER • NEEDLE • BALL

M-R-C BALL BEARINGS

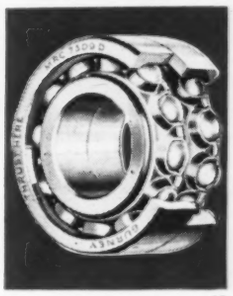
offer a Complete Range of Types and Sizes for Machine Tool Requirements—backed by More than 40 Years of Experience



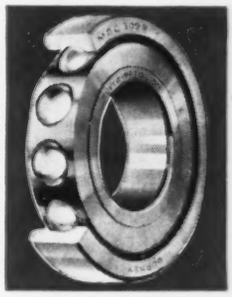
Single-Row—Super-Conrad



Single-Row—Maximum Capacity



Duplex

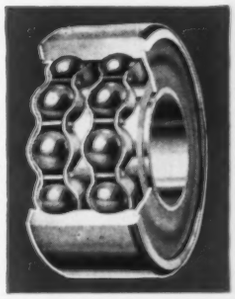


Super-Precision

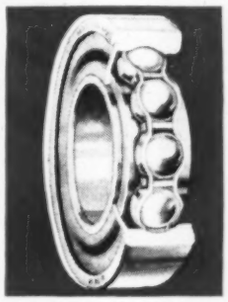
Single-Row—Radial Type R

Leadership

M-R-C Strom SRB GURNEY BALL BEARINGS



Double-Row—Shielded



Single-Row—Single-Shield

MARLIN-ROCKWELL CORPORATION

Executive Offices: JAMESTOWN, N.Y.

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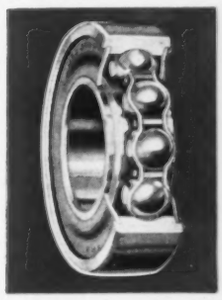
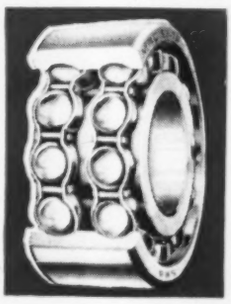
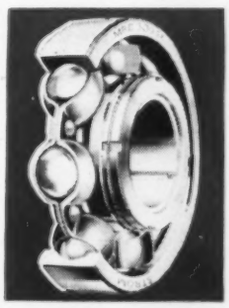


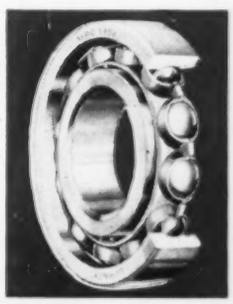
Single-Row—Double-Shield



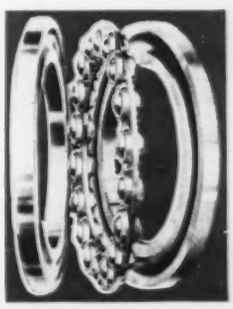
Double-Row



Adapter-Type



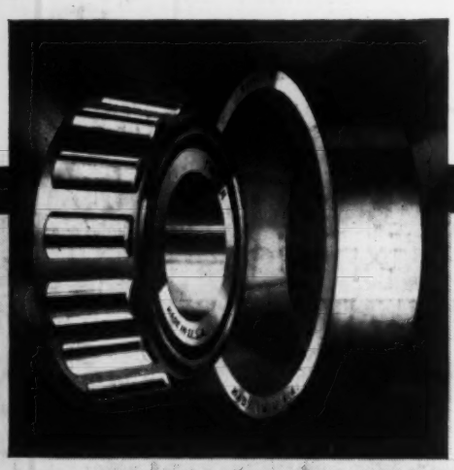
Single-Row—Radio-Thrust



Flat-Thrust

M-R-C *Ball Bearings*

GURNEY ● SRB ● STROM



42 years

OF DEVELOPMENT AND EXPERIENCE

The successful application of roller bearings to any type of equipment requires two basic factors.

FIRST, CORRECT BEARING DESIGN, MATERIAL AND CONSTRUCTION

The TIMKEN Bearing of today is the finest tapered roller bearing that has ever been made. Timken history over a period of 42 years is a story of continual improvement in bearing design—in fact Timken has pioneered every important refinement and improvement ever made in tapered roller bearings. Among these Timken achievements are: the one-piece multiple perforated cage; TIMKEN Electric Furnace Alloy Steel; TIMKEN Bearing surface finish, the finest finish known to modern bearing science; and wide area contact between the ends of the rollers and the under-cut rib of the cone, thus assuring accurate roller alignment around the periphery of the raceways, without which high bearing speeds would be impossible.

SECOND, LONG EXPERIENCE IN APPLYING THE BEARING TO MEET THE PROBLEMS OF ANY TYPE OF EQUIPMENT

Timken has successfully applied bearings to every kind of mechanical equipment. It takes several years to thoroughly prove the successful use of bearings in meeting the individual specialized problems of any given condition of service. Timken's vast fund of experience takes the guesswork out of bearing application.

When you install TIMKEN Bearings you are not experimenting. You get both of these two important basic factors that are so necessary for dead-sure, satisfactory bearing performance: *first,* correct design, material and construction; and *second,* 42 years of engineering experience in applying bearings.

THE TIMKEN ROLLER BEARING COMPANY, CANTON, OHIO

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